Machinery.

ENGINEERING EDITION.

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MACHINERY.

September, 1905.

DRAFTING ROOM OF THE B. F. STURTEVANT CO.

THE new plant of the B. F. Sturtevant Co., Hyde Park, Mass., includes, besides the machine shops, foundry, pattern shop, and other manufacturing buildings, a four-story office building, which is headquarters for the whole business of the company. Here are located the correspondence, designing and drafting offices, the production and cost department, advertising bureau, superintendent's offices, etc. In the basement is a well-equipped printing office devoted to catalogue and circular work. The drafting room occupies the whole of the third floor, while the fourth story is finished and is well lighted through prismatic glass in the north windows, so that it may be occupied by the drafting department when the additional room is needed. From present indications, this space will be put to practical use in the near future, in consequence of the rapid growth of the business of the company, especially since the new plant was completed.

The entrance to the office building is at the center, and there are wide staircases leading to the several floors. At the rear is also an elevator, and on each side of the space devoted to the hall and stairs are large fire-proof storage vaults inclosed in masonry extending from the basement to the top floor. The lower vaults are used by the general offices and the two vaults on the third floor are for the drafting and engineering departments. The entrance to the vaults is through double doors designed by the Mosler Safe Company; each vault is lighted by a single window protected by a fire-proof rolling metal curtain.

In Fig. 3 on the next page is a plan of the third floor, showing the general arrangement of the drafting room. The disposition of the vaults and the elevators is such as to divide the room into two main rooms, and each of these is in turn divided into two departments by rows of lockers, as indicated in the plan and appearing also in Figs. 1 and 2. Inasmuch as the products of the B. F. Sturtevant Co. comprise several distinct classes of machinery, this subdivision of the room is really a convenience, since it enables the draftsmen working in each department to be grouped under the direction of an engineer in charge of the designing for that department.

In Fig. 1 is given as nearly a general view of the room as it is possible to obtain. In the foreground are the drawing tables in one of the four sections of the room, while in the distance, beyond the partitions that inclose the hall, can be seen a part of another section of the room. It will be noted that the lighting from the windows is all that can be desired. At the back or north side of the building the windows are placed very near together and extended from the level of the drawing tables to the ceiling. For artificial light a special electric light fixture has been designed and one of these is placed at each table. It consists of a double-jointed, swinging bracket, carrying a 32-C.P. electric light bulb provided with a parabolic reflector. The bulb is attached to the end of the bracket by a swivel joint. It is therefore possible to place the light at any point over the drawingboard, and also to direct its rays in any direction desired by means of the swivel joint. While in many offices drawing boards are fitted with two stationary electric lights, this plan of providing one light, so arranged that it can be used efficiently, has been found entirely satisfactory.

The type of drawing table used is clearly indicated in Fig. 1. The table was designed by the B. F. Sturtevant Co., and has a top measuring 3 x 5 feet, giving ample space for all standard-size drawings. The top is supported by two up-

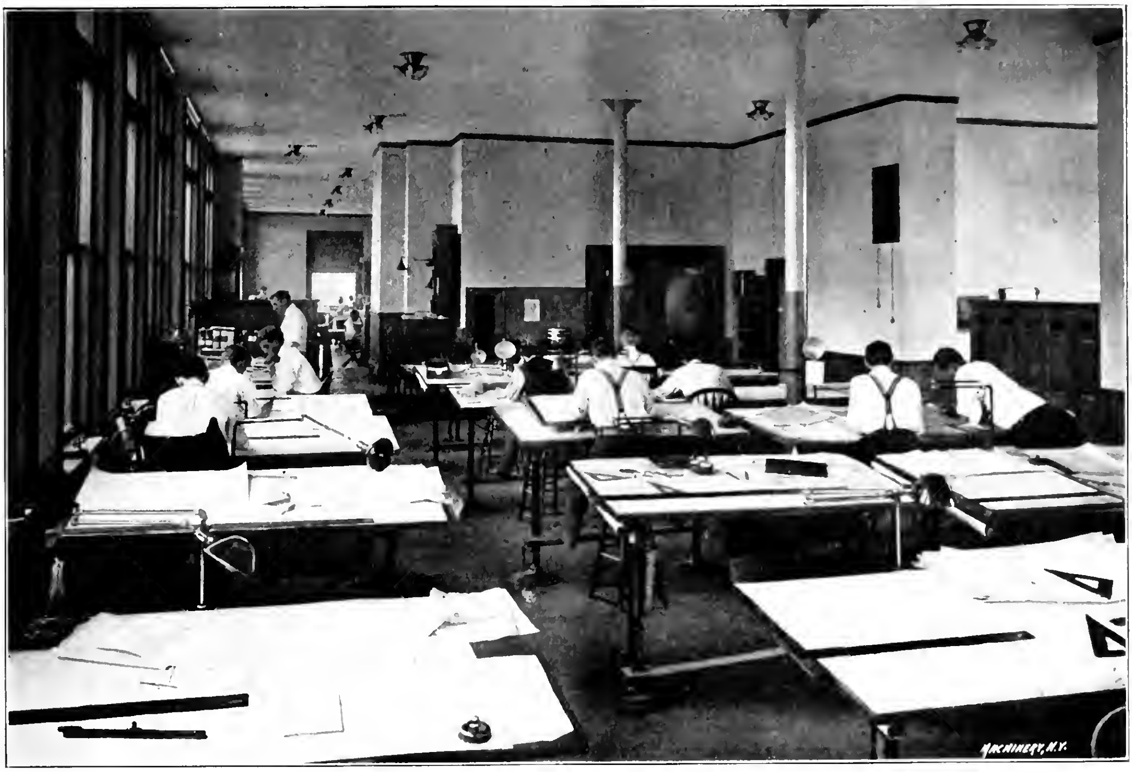


Fig. 1. General View showing one Section of the B. F. Sturtevant Drafting Room.

rights of 1½-inch pipe, screwed into round cast-iron bases fastened to the floor. The upper ends of these uprights fit into adjustable brackets screwed to the underside of the top of the

Fig. 2. View of one Section of Drafting Room, taken from the Center of the Room.

table, supporting it and inclining it to a comfortable angle. The uprights are a sliding fit in these castings, which allows an adjustment of some three or four inches in the height of

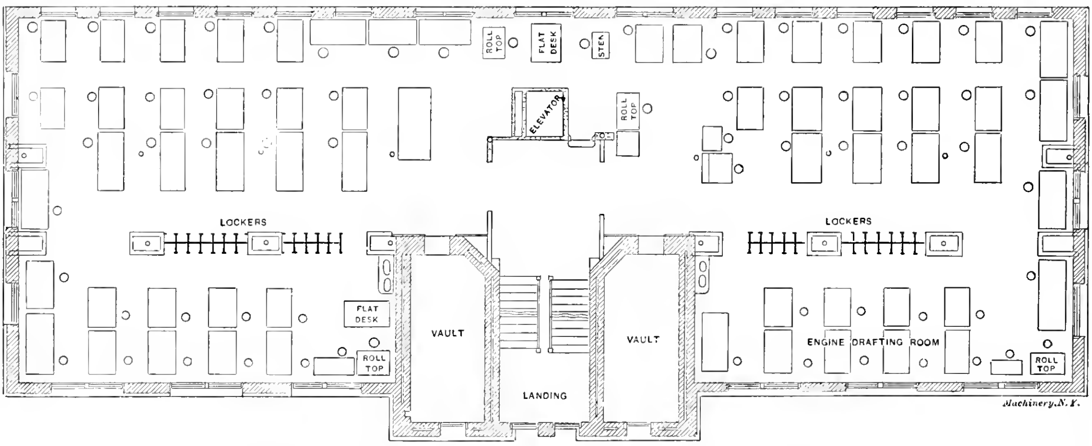


Fig. 3. Plan of Third Floor of Office Building, which is Occupied by the Drafting Room.

the table, the position being fixed by setscrews. A wooden foot rest consisting of a long strip extending from one side to the other can be clamped in any position desired by the draftsmen. A single instrument drawer is provided for this type of table.

Fig 10 shows the details of a longer, 7-foot table of the same general design, which is used by the Sales Engineering Department. It will be noted that the large shallow drawer, intended for drawings, has a horizontal strip at the back to prevent the drawings curling up and slipping out at the rear.

The heating and ventilation of the drawing room, as well as all of the other departments of the plant, is by the Sturtevant forced-blast system. In the office, warm and cold air, mixed under thermostatic control, is admitted through a series of ducts built in line with the rows of lockers, Fig. 3, near the center of the room.

Fig. 4 is a view looking into one of the vaults, which shows the fireproof doors, and Fig. 5, which is an interior view, gives a general idea of the filing cases designed for the drawing and other records.

In Fig. 6 is a view of the blueprint room, which is located in the attic. This room has no unusual features, but is conveniently arranged. There are ample washing trays and drying racks and there are three printing frames that may be used either for printing by sunlight or by electric light. When used with the artificial light the frames remain in the blueprint room and a large hood, or reflector, carrying two small arc

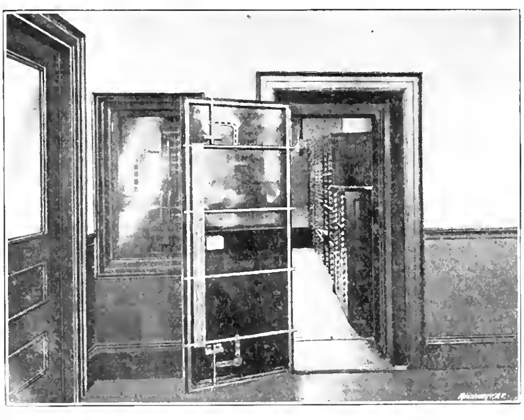


Fig. 4. Entrance to one of the Storage Vaults.

Fig. 5 Interior of one of the Storage Vaulte

lamps, is suspended over the frame containing the drawing to be printed. The reflector and lamps are supported by a trolley on overhead tracks, one of which appears at the left in Fig. 6, so they can be located over any one of the three frames for printing in rainy weather or during the latter part of the afternoon.

Fig. 7 shows the platform where the sunlight printing is done, which is arranged in quite an original manner. The office building faces south so that it was necessary to use windows in the front of the building for the printing frames. Inasmuch as these frames would present an unsightly appearance in so prominent a location as the front of the building, the arrangement shown in Fig. 7 was decided upon. It will be noticed that a portion of the roof at the front of the building is cut away sufficiently to allow of a door and windows, to open upon an outer platform, which is substantially on a level with the floor of the blueprint room. This platform, however, is hidden from view by a wall some five feet high around the two sides and front of the platform. This wall is a part of the main wall surrounding the section of the building which contains the entrance, staircases and halls, and which projects a few feet beyond the main wall at the front of the building, breaking up what would otherwise be a severely plain exterior, and giving a pleasing architectural effect. By extending this wall to beyond the top floor, as shown in Fig. 7, the blueprint platform was secured with a southern exposure and at the same time it is entirely hidden from view.

Fig. 6. Interior of Blueprint Room.

Fig. 7. Platform where Blueprinting by Sunlight is Done.

Production List—Production Orders.

It is now quite commonly the practice in manufacturing establishments to prepare lists in the drafting room of the parts comprising a machine, giving at the same time the drawing number, the pattern number, etc., for each piece. The B. F. Sturtevant Co. was one of the first to introduce this system, and a copy of one of the production lists is shown on a reduced scale in Fig. 8. This list, as partially filled in in the engraving, is self-explanatory. The blank is printed on thin paper and the different items, with their corresponding numbers, are lettered with black ink so that blueprints can be taken from a sheet for distribution.

The production list is used only in connection with production orders and not in connection with mere shipping orders that may cover the same articles already completed on production orders. One blueprint copy of the production list goes to the production department, and one to the machine department. The former employs it to make out a list of material, etc., for its production orders, the latter as a general reference list.

In Fig. 9 is a reproduction of a production order which in this case, is issued by the production department to the machine department. This gives the order number for the cylinders of a lot of fifty 10 x 12 engines, twenty-five of which are right-hand and twenty-five left-hand. It gives the pattern number, the drawing number, the number of the production list, states that the cylinders are to be made for stock, etc. The blank also is to be filled in with the time required for

14 x 16 HORIZONTAL AUTOMATIC ENGINE TYPE · H.C.I.

B. F. STURTEVANT CO., HYDE PARK, MASS.

A PRODUCTION LIST T-3551

April 21, 1904

ERECTION DRAWING / NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION	NO. OF PCS.	MATERIAL.	NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION	NO. OF PCS.	MATERIAL.
Bed	6-1311	14136	1	C.I.					
Bed Cover		19881	2	C.I.					
Tap Bolts		3/8" x 3/4"	8	W.I.					
					Cylinder	6-1305			
Connecting Rod	6-1308				Body	"	10556	1	C.I.
Body	"	Pc 14106	1	Steel	Lagging (St. & Ex. Side)	6-1663	11991	2	"
Crank Box (Out Half)	"	14103	1	C.I.	" Round	"	11990	2	"
" " (In Half)	"	14104	1	"	Studs (Back End)	6-1305	1 1/8" x 3 5/8"	8	Steel
Bolts	"	Pc 14105	2	Steel	" (Front End)	"	[illegible] x 5 1/2"	8	"
Nut	"	1 7/8" Hex.	4	W.I.	Machine Screws	For Lagging	#20-18		
Split Pins	"		2	Steel	Nuts	6-1305	1 1/8" Hex.	16	W.I.
Wrist Box (Out Half)	"	014109	1	Comp.	Steam Chest Studs	"	[illegible] x 3 5/8"	12	Steel
Wrist " (In Half)	"	014108	1	"	" " Nuts	"	[illegible] Hex.	12	W.I.
Strap	"	Pc 14107	1	Steel	Head (Front End)	See P.st Rod Stuff. Box.			
Key	"	Pc 14110	1	"	Head (Back End)	6-365	10562	1	C.I.
Bolt	"	Pc 14111	2	"	Cover	"	12234	1	"
Nut	"	1" Hex.	2	W.I.	Bolt	"	3/4" x 2 [illegible]	1	Steel
Set Screw	"	3/4" x 2 1/8"	1	Steel	Lock Screws	"	[illegible]	2	"

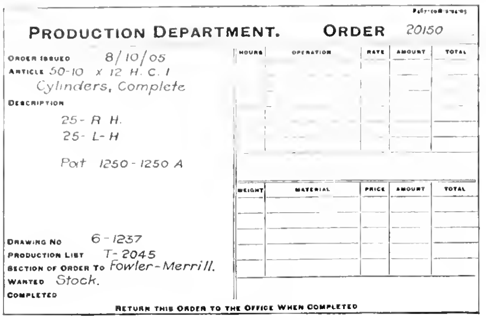
Fig. 8. Production List.

the different operations, and later, in the office with the costs of both the operation and materials entering into the work. This order, as shown, is a general order for the cylinders.

There are also issued sectional orders for each different operation, such as planing, boring, etc., stating the price per piece if the work is to be piecework, and having blank spaces reserved for materials used, the date the work is completed, and when it has received inspection.

Subdivisions of the Office.

As our readers know, the business of the B. F. Sturtevant Co. was primarily the manufacture of blowers. This naturally


PRODUCTION DEPARTMENT. ORDER 20150

ORDER ISSUED 8/10/05
ARTICLE 50-10 x 12 H. C. I
Cylinders, Complete
DESCRIPTION
25- R H.
25- L-H
Pat 1250-1250 A

HOURS	OPERATION	RATE	AMOUNT	TOTAL

WEIGHT	MATERIAL	PRICE	AMOUNT	TOTAL

DRAWING NO 6-1237
PRODUCTION LIST T-2045
SECTION OF ORDER TO Fowler-Merrill.
WANTED Stock.
COMPLETED

RETURN THIS ORDER TO THE OFFICE WHEN COMPLETED

Fig. 9.

led to various allied branches, such as heating and ventilating apparatus, mechanical draft apparatus, etc. It also led to the manufacture of engines and motors to operate the blowers, and later of generators which are chiefly used in connection with the engines for electric lighting both in stationary power plants and in marine service. Supplementary to the mechanical draft apparatus and other machinery and appliances built may be needed to meet the requirements, the special work thus consisting mainly in the piping, framing, and sheet metal work, which is different in nearly every case.

To facilitate the handling of these lines in the drafting room there are separate departments, over which is an engineer having his own corps of draftsmen who look to him for directions in regard to construction work, although they are under the foreman of the drafting room in so far as the general management of the room is concerned.

One of these departments is the Sales Engineering Department, which attends to all work relating to the combining of individual units, except in the case of generating sets. This is the general drafting department. All designs for fans, heaters, economizers, and the like, as well as the combination of fans and engines, fans and motors, fans and heaters, etc., and all drawings showing applications such as those for mechanical draft, heating and ventilating, exhausting, etc., are made here.

It is the province of the sales engineering department to enter the sales orders for the special apparatus or installations for which it makes the drawings. All the orders for standard goods are entered by the Sales Department. Sales orders are written in manifold, the first copy furnishing the record file copy, the second passing to the production department for binding in a loose leaf binder, the third being retained for checking by the accounting and other departments, and a fourth being made only when necessary as a memorandum to be sent to the branch office from which the order is received. A final copy is made upon a 5 x 8-inch card, commonly known as the shipping card, which passes to the shipping department in the works.

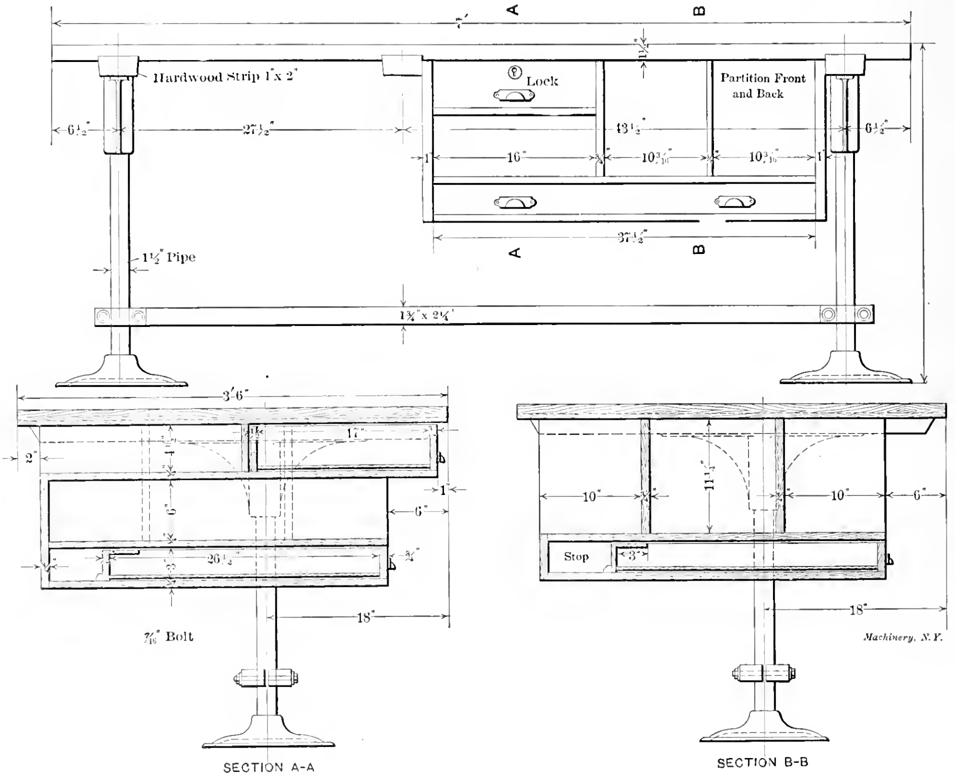


Fig. 10. Details of a Seven-foot Drawing Table.

for power plant use, have been added the manufacture of economizers, exhaust heads, etc. It will be noted that these several products are, to a considerable extent, different in character, certain of them being such as could be readily manufactured on the interchangeable plan, and others like heating, ventilating and mechanical draft apparatus, being built to meet the needs of each individual customer. These latter, however, are largely made up of standard machines by assembling such sizes of engines, motors, blowers, etc., as

Drawings.

Drawings are made upon standard size sheets, 9 by 12 inches, 18 by 26 inches, and 24 by 36 inches; the latter being seldom used. Drawings requiring very large sheets are made in multiples of these sizes and folded.

Drawings are designated entirely by numbers. The first number entered on a sheet is indicative of its classification: 6, for instance, indicating engines; 7, electrical apparatus; 15, installations and combinations of apparatus, etc. Following

this number is a dash after which comes the number of the drawing itself in numerical order for the particular class of work shown on that drawing. For example, 15—9145 would indicate drawing No. 9145 of class 15. All numbers are taken consecutively as drawings are made, and locations in the drawer are determined by the card index which is very carefully maintained. Drawings are filed fifty in a drawer. In addition to the designating numbers it is sometimes found necessary to use suffix letters, as, for example, where the group of installation drawings refers to the same plan or building.

Prod. Order 2662 6 **Size** 10 × 10 H. C. 1 Engs.
Prod. List T-1924 Aut.
T-1075 Thrott.

Serial No.	Shipping Order	Shipped	Name	Total of Given Size
9281	98523	Jun. 29/03	Monarch Cotton Mills, Union, S. C.	34
9282	105510	Jun. 25/03	Owosso Sugar Co., Owosso, Mich.	35
9283	104000	Sep. 28/03	Brandon Mills, Greenville, S. C.	36
9284	109470	Oct. 17/03	Portland Co., Freeport, Me.	37

Fig. 11. Record of Shipments.

The drawings of combinations of apparatus such as are prepared by the sales engineering department do not contain details of the different machines, but simply show their relative locations, the dimensions and arrangement of foundations, the castings, heating coils, sheet metal work, framing, etc. The drawings for the regular machine work, however, such as the engine work, contain all details and necessary directions for the workmen. The patterns and piece numbers run consecutively and these numbers are placed on the drawings. There is also a material list showing the number of pieces, the number, name, material, and, where necessary, a column is allowed for explanatory remarks.

In many drafting rooms a great deal of time is spent in lettering the title of the drawing and various plans have been devised to bring about uniformity in the appearance of the title and to reduce the expense of this part of the work. The plan here is to print the name of the firm and other items usually accompanying the title such as the words, "scale," "drawn by," "checked by," "order number," "drawing number," etc., on standard size sheets of tracing paper. This printing is done on a regular printing press with printers' ink. The name of the machine or part of the drawing is then stamped in its proper place, and the several items are filled in by the draftsman, or the persons whose signatures are necessary.

NO. 9284 SIZE 10 x 10 H.C. 1 Engine DATE SHIPPED Oct. 17, 03

Shipping Order 109470 — Portland Co., Freeport, Me

Hand R.H. Runs Over

Steam Pres. 100 Lbs.

R. P. M. 350

Governor Rites. — Drawing 6-1008

Band Wheel 48" x 12½ — Production Order 2662 — Prod. List T-1924

Wt. Wheel 450 lbs. — Memoranda: - Thrott Valve Gravity Oiling System.

Eccentric Auto

Cut off Auto.

Application

Fig. 12. Record of Engines Shipped.

Blueprints intended for shop use are mounted on heavy cardboard; if they are to be in continuous use. Where only a single piece of apparatus is to be made, however, they are not mounted. Aniline sketches are quite generally employed for small apparatus of the latter class. One copy of the sketch is made in a copybook, and card indexed, while others are mounted on cards for shop use.

Great care is taken to maintain a complete record of all shipments to facilitate repairs. These records are kept by a card index upon cards 5 by 8 inches in size. To illustrate, as soon as the production order is issued for a lot of engines the serial number of the engine is written on one of these cards; and as fast as the engines are shipped the shipping order is entered in the proper column, together with the date, the name of the customer, and the total number of the given size which have thus been shipped. One of these cards when filled out has entries similar to those shown in Fig. 11. At the same time another 5 by 8 card, of which a reproduction on a reduced scale appears in Fig. 12, is filled out for the specific engine number, and the customer's address and the engine number are entered on a 3 by 5-inch card which is alphabetically filed. The 5 by 8-inch card represented in Fig. 11 is filed by engine size; and the one illustrated in Fig 12, by engine number.

Another vexing problem in drafting room practice is that of taking care of the changes, odd sizes, etc. If the article, after it has been changed, is of such character that it can be substituted for the article first made, the alteration is made upon the tracing; otherwise the blueprint first taken is marked "for record," and shows the piece as it was originally made. The necessary changes are then made on the tracing and a new number given to it. The same policy holds regarding changes in pattern and piece numbers, and in the production lists. In making any of these illustrations the main thing is to be absolutely certain that a specific number for a drawing, patent, or production list always means the same thing.

* * *

STUDY THE MARKET.

That it is necessary for manufacturers to study their markets and adapt their goods to them is at least a half-truth. In many cases a market can be worked up for a new product developed under conditions totally different from those that obtain in foreign countries, but the foreign market having no preconceived ideas as to what the machine or other products should be, accept it without protest. On the other hand, where such preconceived ideas do exist it behooves the manufacturer to go slow in trying to introduce his product if it differs widely from that to which foreign customers are familiar. An example in point is the experience of a certain American bicycle manufacturing concern which made strenuous efforts to introduce American bicycles in Great Britain. It cost them something over $25,000 in advertising and experience before they struck the right track. The manager of one of the English branch houses said: "We have made a success of manufacturing bicycles for the British trade after it had cost us $25,000 in advertising and experimentation. We took hold of the wrong end of the proposition, determining that we would sell the American type of wheel to the Englishman. We were incensed that he wanted the old mud guards that would not be tolerated here. It was folly to us that the Englishman insisted upon the steel rim when we knew wood was so much better. That our perfected hub brake should be overlooked in favor of the old rim brake operated from the handle bar was ridiculous. But after two years and the loss of many thousand dollars, we are making the Englishman's wheel just as the Englishman wants it, and our foreign trade in the bicycle has increased until branch establishments in Liverpool and in London have become necessary to our growing business.

* * *

Before alcohol can come into general use for industrial purposes it must be rendered unfit for drinking. One method for doing this, according to *The Engineer*, and still leave it unharmed for legitimate purposes, is to dissolve in it acetylene gas.

PULLEY AND GEAR ARMS.

ROBERT S. BROWN.

Notation.

b = Belt width in inches. d = Diameter, inches. f = Face, inches.
h = Arm width projected to center of pulley or gear.
h_1 = Arm width at rim. n = Number of teeth in gear.
Pc = Circular pitch. Pd = Diameter pitch.
S = Working stress per square inch of section.
t = Rim thickness. y = Tooth factor in the Lewis formula.
Z = Resisting moment of section.

Elliptical Section Arms.

Elliptical section arms, as in Fig. 1, are commonly used and on ordinary sized pulleys six arms are satisfactory. The

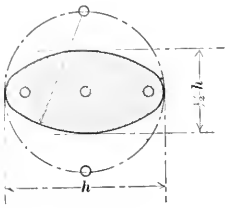


Fig. 1.

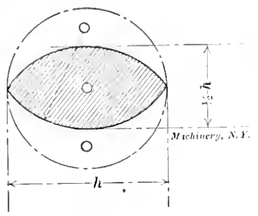


Fig. 2.

following formulas are all based on the use of six arms. For other numbers of arms, see Unwin, Suplee or Reuleaux. Dimension h may taper to h_1, ¼ inch in 12 inches on each side.

$$Z = \frac{h^3}{20.367}, \text{ or roughly, } Z = 0.05\,h^3$$

Lenticular Section Arms.

Lenticular section arms, Fig. 2, are recommended by Unwin as "looking lighter" and have been adopted by Sellers, Sweet and others. In these, $Z = 0.04h^3$, or slightly less than in the elliptical sections. In the formulas following this value for Z has been introduced so that the resulting arms will be strong enough for either lenticular or elliptical section.

Single and Double Armed Pulleys.

Kent assumes a belt pull of 45 pounds for single and 90 pounds for double belts per inch of width. S is taken at

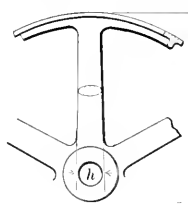


Fig. 3.

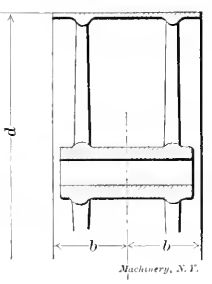


Fig. 4.

3,600 pounds and the belt pull as all coming on one half the number of arms. For single belts, $h = 0.348 \times \sqrt[3]{bd}$. For double belts, $h = 0.4389 \times \sqrt[3]{bd}$. *Log.* $0.348 = \bar{1}.54202$. *Log.* $0.4389 = \bar{1}.64236$.

Above gives results agreeing with Unwin and the table in the International Correspondence Schools' Hand Book. If two sets of arms are used, consider as two pulleys, Fig. 4, and calculate accordingly. Multiply dimensions found by $\sqrt[3]{\frac{1}{2}}$ or 0.8 approximately.

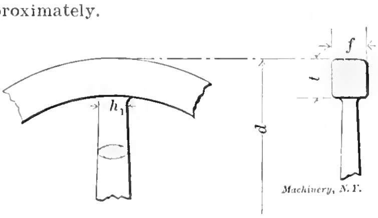


Fig. 5.

Flywheel Arm.

On flywheels, Fig. 5, from 33 to 96 inches diameter, F. A. Halsey, in the *American Machinist*, April 23, 1896, proposes $h_1 = 0.875 + 0.04d + 0.153\ \sqrt[2]{ft}$ as amply strong and symmetrical. He prefers $f = 2/3\ t$.

Spur Gear Arms.

In gear arms, Fig. 6, S is assumed by Unwin at 5/7 of unit of stress on tooth (3,000 and 4,200 pounds being taken). $h = 0.524\ \sqrt[3]{P_c fd}$ or $h = 0.7677 \sqrt[3]{\frac{fd}{P_d}}$. Log. $0.524 = \bar{1}.71945$. Log.

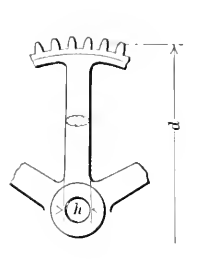


Fig. 6.

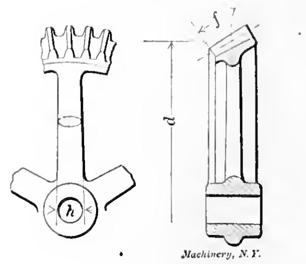


Fig. 7.

$0.7677 = \bar{1}.88517$. In using the Lewis formula (see Kent pp. 900-1)

$h = 0.7177\ \sqrt[3]{P_c^2 fyn}$ or $h = 1.5395 \sqrt[3]{\frac{fyn}{P_d^2}}$. Log. $0.7177 = \bar{1}.85593$, Log. $1.5395 = 0.1874$. Suplee has a table, p. 466, where $h = 2\ P_c$ and the number of arms is varied with n.

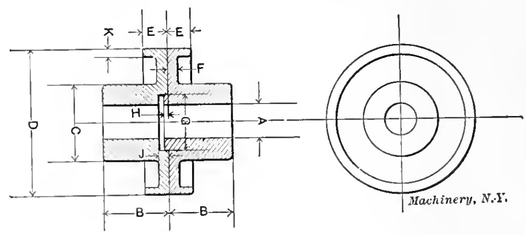
Bevel Gear Arm.

In bevel gears, Fig. 7, use mean diameter and mean pitch and calculate as for spur gears. The above formulas on gears are adapted from the text book of the International Correspondence Schools.

* * *

A CORRECTION.

We regret to say that there is an error in data sheet No. 47, in the August issue of MACHINERY. The cut for the sheet of dimensions for safety flange couplings has been corrected and is shown below. As will be noticed the location of dimension H has been changed. This makes the clearance



between the shoulder on one coupling and the counterbone in the other, a constant amount of 1/32 of an inch. As shown in the cut in the data sheet, the dimensions given in the table would give a constant height to the shoulder of only 1/32 of an inch.

* * *

ALLOYS HAVING LOW FUSING TEMPERATURE.

The following is a list of compositions that will melt at a very low temperature, making them suitable for so-called "safety metals." Any of these compositions will melt at a temperature very much lower than the melting temperature of any of the metals in the composition.

1. Bismuth, 8 parts; lead, 5 parts; tin, 3 parts. This composition will melt at a temperature of 202.1 degrees F.
2. Bismuth, 2 parts; lead, 1 part; tin, 1 part. This alloy will melt at a temperature of 200.75 degrees F.
3. Bismuth, 5 parts; lead, 3 parts; tin, 2 parts. This alloy will melt at a temperature of 196.9 degrees F.
4. Bismuth, 4 parts; lead, 2 parts; tin, 1 part; cadmium, 1 part. An alloy made in this proportion will melt at a temperature of 140.9 degrees F.

SYSTEMATIC METHOD OF COMPUTING CENTRIFUGAL STRESSES.

SANFORD A. MOSS.

In this article is given a convenient system for the computation of stresses in rotating bodies due to so-called "centrifugal force." No derivation or proof of the various formulas is given.

The fundamental quantity of our system will be c, the centrifugal force in pounds, exerted by a concentrated weight of 1 pound, whose center of gravity rotates in a circle one inch in diameter, with a speed of N revolutions per minute. We have

$$c = .00001421\ N^2. \tag{1}$$

One who has much computation work to do will find it convenient to prepare a table of the values of c for the values of N most frequently used.

The centrifugal force in pounds (that is, the inward radial force which must be applied at the center of gravity), for a concentrated mass whose weight is W pounds, and whose center of gravity rotates in a circle d inches in diameter, is expressed by the formula:

$$\text{Centrifugal force} = cWd. \tag{2}$$

In computing stresses due to centrifugal force, our fundamental method will be to compute directly F, the "bursting force," in pounds, tending to cause rupture. The stress is of course the bursting force divided by the area. The "bursting force" is understood to be the force in pounds applied to *each* of the two cross-sections of the ring, disk, etc., which are on opposite sides of the axis. That is to say, the total force tending to cause rupture across the whole area on both sides of the axis, cut out by a plane containing the axis is twice the "bursting force."

Rule 3: Hence, in order to obtain the stress, the sum of the bursting forces due to all causes must be divided by the area in square inches of the solid metal (deducting holes, etc.), *on one side of the axis only.* (3)

The use of rule (3) will give only the "average stress," throughout the section. If the cross-section has considerable length in the directions of the radius, the stresses may not be distributed uniformly. Then in various parts of the section, the stress is above and below the average. The exact way in which the stress is distributed is a matter of considerable complexity and uncertainty.

Rule 4: For most purposes it is best to use only the "average stress" as given by rule (3), making the stress and factor of safety such as to allow for any variation of stress above the average which may occur, according to the judgment of the designer. (4).

The section of the disk, ring, etc., should be made such as to give a uniformly distributed stress, whenever possible. For instance, in the case of a disk the thickness (in the direction of the axis) should be much greater at the hub than at the rim. In other words, it is best to place additional metal for resisting stress near the hub where the bursting force of the added metal will be least.

The shape of section which will give uniform distribution of stress can be computed mathematically for any case.

Rule 5: In many cases, it will be sufficient if designer simply thickens the section toward the hub according to his judgment as to what will give uniform stress as nearly as possible under the given circumstances. This is not a scientifically correct procedure, but the mathematical difficulties of the exact methods and the usual large factor of safety justify it. In this case the factor of safety becomes partly a "factor of ignorance." (5)

The bursting force, F, due to n concentrated masses (such as arms, gear teeth or poles on a revolving field), each of weight W pounds, whose centers of gravity are uniformly distributed completely around a circle of diameter d inches is expressed by the formula

$$F = \frac{c\,W\,d}{2 \sin \dfrac{180}{n}} \tag{6}$$

(6) gives exactly the bursting force across a section midway between two masses, where it is a maximum. The bursting force across the section at the radius through the center of gravity of a mass is less and is found by using *tan* instead of *sin* in (6). The two values are not appreciably different unless n is small.

An approximate formula equivalent to (6) and giving nearly correct results where n is greater than 8, and almost exact results for large values of n, is

$$F = \frac{c\,W\,d\,n}{2\,\pi} \tag{7}$$

Next, let us consider the bursting force due to the metal composing a ring, disk, etc., of any cross section. As already remarked, the cross section is the plane figure, on one side of the axis only, cut out by a plane containing the axis.

Formulas for the Bursting Force of a Ring, Disc, Etc.

w = density of metal, pounds per cubic inch.

$W = \pi\,w\,A\,d$ = weight in pounds of the complete disk or ring (whole circumference).

d = diameter in inches of circle through center of gravity of cross section.

$r = \dfrac{d}{2}$ = distance in inches from axis of rotation to center of gravity of cross section.

A = area of cross section in square inches.

I = moment of inertia of plane figure forming cross section, about an axis through its center of gravity, parallel to axis of rotation.

$I' = Ar^2 + I$ = moment of inertia of cross section about axis of rotation.

(A systematic method of finding r A and I was given by the writer in MACHINERY, June, 1903. A condensed method, without automatic checks, for finding A, r and I' is given in the table at the end of the article.)

d_1 = inner diameter of ring or disk in inches.

d_2 = outer diameter of ring or disk in inches.

t = uniform thickness of a flat disk or ring, in the direction of the axis.

F = bursting force in pounds due to metal of ring, disk, etc., applied to cross section on one side of axis.

For a ring, disk, etc., of any cross section:

$$F = 2\,c\,w\,(A\,r^2 + I) \tag{8}$$

or

$$F = 2\,c\,w\,I' \tag{9}$$

or

$$F = \frac{c\,W\,d}{2\,\pi}\left\{1 + \frac{4\,I}{A\,d^2}\right\} \tag{10}$$

For a ring, whose outer and inner radii are nearly the same, approximate formulas are:

$$F = 2\,c\,w\,A\,r^2 \tag{11}$$

or

$$F = \frac{c\,w\,A\,(d_1 + d_2)^2}{8} \tag{12}$$

or

$$F = \frac{c\,W\,d}{2\,\pi} \tag{13}$$

or

$$F = \frac{c\,W\,(d_1 + d_2)}{4\,\pi} \tag{14}$$

The *stress* in a ring whose radii are nearly the same is approximately,

$$\frac{.3732\,w\,V^2}{e} \tag{15}$$

where V is the velocity in feet per second and e is the ratio of the area effective for resisting stress to the average area, *i. e.*, the "efficiency of joint."

For a flat ring or disk or cylinder with a hole in it, of uniform thickness in the direction of the axis

---

Sanford A. Moss was born in San Francisco, Cal., in 1872. He served an apprenticeship as a machinist with Edward A. Rix and afterwards became a journeyman machinist with the California Gas Engineering Co. He then entered the mechanical engineering department of the University of California, graduating in 1896. He alternated practical work as a draftsman for various machine works, with post-graduate college work in mechanical engineering at the University of California and at Cornell University, where he received the degree of Doctor of Philosophy. In 1901 Mr. Moss became instructor in machine design at Cornell University, resigning in 1903 to accept his present position in charge of experimental research work for the steam turbine department of the Lynn works of the General Electric Co. His specialty is the mathematical side of engineering.

$$F = \frac{c\,w\,l}{12}\,(d_2^3 - d_1^3) \qquad (16)$$

or

$$F = \frac{c\,W}{3\,\pi}\left(d_1 + d_2 - \frac{d_1\,d_2}{d_1 + d_2}\right) \qquad (17)$$

Computation of Stress in an Impellor.

As an example of the methods of using the preceding formulas, we will compute the stress in the cast iron impeller of a centrifugal pump, 34 inches in diameter, rotating at 1,000 revolutions per minute. The impeller consists of a central disk, with bosses at the center forming the hub. On both sides of the disk are cast ribs forming the vanes. The disk is thickened at the hub so as to make the stress uniform according to rule (5). The thickness in the direction of the axis just outside the hubs is 3 inches. The thickness gradually decreases and becomes ½ inch at the circumference. There are 20 vanes on each side extending from inlet to circumference, and 20 more on each side beginning about half way out and extending to the circumference.

The weight of one of the long vanes was computed to be 4 pounds, and the weight of one of the short vanes was 2 pounds. The diameters to the centers of gravity of the vanes were computed to be 26 and 20 inches respectively. The plane figure forming the cross section of the disk was worked up in tabular form, as shown in the table, and the area found to be $A = 28$ square inches, and the moment of inertia about the axis of rotation found to be $I' = 1143.8$. This data and the preceding formula enable us to compute the stress, as follows:

In the first place, by formula (1)

$$c = .00001421 \times 1000 \times 1000 = 14.21.$$

The bursting force due to the long vanes on both sides by formula (7) is:

$$F_1 = \frac{2 \times 14.21 \times 4 \times 26 \times 20}{2 \times 3.1416} = 9{,}408 \text{ pounds.}$$

The bursting force due to the short vanes on both sides, by the same formula, is:

$$F_2 = \frac{2 \times 14.21 \times 2 \times 20 \times 20}{2 \times 3.1416} = 3{,}618 \text{ pounds.}$$

Next we will compute the bursting force due to the metal of the disk itself, by formula (9). We will take w, the weight of cast iron per cubic inch, as .26. We have,

$$F_3 = 2 \times 14.21 \times .26 \times 1143.8 = 8{,}450 \text{ pounds.}$$

The total bursting force is

$$F_1 + F_2 + F_3 = 9408 + 3618 + 8450 = 21{,}476 \text{ pounds.}$$

This is resisted by the metal forming the cross section of the disk, 28 square inches. Hence the stress is 21,476 ÷ 28 or 767 pounds per square inch. This is a proper stress for cast iron under the circumstances, and hence the impeller is safe.

Computation of Stress in a Flywheel.

Let us take as a second example a six-arm cast iron flywheel, rotating at 100 revolutions per minute, built in halves and held together by the usual steel link-bars at the rim and by bolts at the hub. Let the outside diameter be 12 feet, the inside diameter of the rim 10 feet, and the thickness of the rim in the direction of the axis 12 inches. The total area on each side of the link bars is 16 square inches, and of the cast iron at the minimum section, 128 square inches. Let the hubs be 12-inch bore and 24 inches long, and of a shape equivalent to an outside diameter of 30 inches. Let the average cross section of the arms be 50 square inches. The fillets at the ends, etc., are such that the weight of each arm is the same as that of an arm with a cross section of 50 square inches, which is 52 inches long. The estimated radius to the center of gravity of the arms is 35 inches. The hub is held together by two 2¼-inch bolts on each side; area at root of thread, 3.14 square inches each.

In the first place, by formula (1)

$$c = .00001421 \times 100 \times 100 = .1421.$$

The weight of an arm is $50 \times 52 \times .26 = 676$ pounds. The bursting force due to the arms by formula (6), is

$$F_1 = \frac{.1421 \times 676 \times 70}{2 \times \sin 30°} = .1421 \times 676 \times 70 = 6{,}724 \text{ pounds.}$$

The approximate formula (7) would have given

$$\frac{.1421 \times 676 \times 70 \times 6}{2 \times 3.1416} = 6{,}421 \text{ pounds.}$$

which is considerably in error.

The bursting force due to the hub by formula (16) is

$$F_2 = \frac{.1421 \times .26 \times 24}{12}\,(30^3 - 12^3) = .1421 \times .26 \times 2 \times 25272 = 1{,}868 \text{ pounds.}$$

The bursting force due to the rim, by formula (16) is

$$F_3 = \frac{.1421 \times .26 \times 12}{12}\,(144^3 - 120^3) = .1421 \times .26 \times 1{,}258{,}000 = 46{,}480 \text{ pounds.}$$

The approximate formula (12) would have given $\frac{1}{8} \times .1421 \times .26 \times 144 \times 264^2 = 46{,}350$ pounds, which is nearly correct.

Let us suppose that the rim takes care of its own bursting force, and the hub supports itself and the arms. The stress on the link bars is then $46{,}480 \div 16 = 2{,}900$ pounds per square inch, and on the cast iron is $46{,}480 \div 128 = 363$ pounds per square inch. The total bursting force on the hub bolts is $6724 + 1868 = 8{,}592$ pounds, and the stress is $8592 \div 6.28 = 1{,}370$ pounds per square inch. These stresses are extremely low and the wheel is therefore of ample strength.

Table showing Systematic Method of Finding the Moment of Inertia of any Plane Figure about any Given Axis.

(The axis may or may not be the axis through the center of gravity. If the bursting force of the figure is being computed, the axis should be the axis of rotation.) The figure must first be divided into rectangles or triangles, whose bases are parallel to the given axis. These subdivisions are labeled A, B, C, etc., in Col. 1. They are marked R or T in Col. 2 according as they are rectangles or triangles. The breadth parallel to the axis is placed in Col. 3 and the height, perpendicular to the axis, in Col. 4. The distance of the center of gravity of each subdivision from the given axis, is placed in Col. 5. The center of gravity of a rectangle is at one-half its height, and of a triangle at one-third its height.

1	2	3	4	5	6	7	8	9
Part.	Rectangle or Triangle.	Breadth.	Height.	Distance of C. of G. from Axis.	$b\,h/2$ if T, $b\,h$ if R.			$x \times a\,x$ and $\frac{b\,h^3}{36}$ if T, or $\frac{b\,h^3}{12}$ if R.
		h	h	x	a	$a\,x$	h^3	
A	T	2.28	9.68	9.04	11.03	99.8	907.0	902.0 57.4
B	R	1.18	3.86	3.93	4.56	17.9	57.51	70.3 5.7
C	R	1.11	4.02	3.81	4.46	17.0	64.96	64.8 6.0
D	T	1.92	1.90	2.63	1.82	4.8	6.86	12.6 0.4
E	T	1.60	1.76	2.71	1.41	3.8	5.45	10.3 0.2
F	R	1.90	0.30	1.97	0.57	1.1	0.03	2.2 0.0
G	R	6.62	0.625	1.69	4.14	7.0	0.24	11.8 0.1
......	......	......	......	......	27.99	151.4	......	1143.8

Area $= A = 28.$ square inches.
Moment of inertia about given axis $= I' = 1143.8.$

(*Additional Properties.*—Distance of center of gravity from given axis, $= r = \Sigma\, a\,x/A = 151.4/28 = 5.41$ inches. Moment of inertia about neutral axis, *i. e.*, axis through center of gravity, $= I = I' - A\,r^2 = 1143.8 - 819.3 = 324.5$). .. ....

* * *

The ammeter may be successfully used as a speed indicator by connecting it to a small dynamo having a permanent field magnet, the dynamo being driven, of course, directly from the part the speed of which is to be measured. With such a dynamo the deflection of an ammeter needle is directly proportional to the speed.

CONE PULLEY RADII.

JOHN J. HARMAN.

The problem of determining the radii of a single pair of pulleys to transmit a given velocity ratio is so very elementary in its nature that one would not at first thought imagine it to be a difficult matter to proportion a series of these pulleys on the same shafts to transmit other given velocity ratios. However, this calculation, when an open belt is to be used, is probably of a more complex nature than any other minor operation in machine designing.

The one condition which causes a multitude of troubles is the fact that the same belt must fit with equal tension on the different steps—or pulleys—of the cone. This condition makes the problem an exceedingly difficult one for exact analytical solution. Approximate formulas are to be found in Kent's "Mechanical Engineer's Pocket Book," and other engineering treatises of the same nature, which handle the problem from a purely analytical standpoint, but they are at best very complicated and laborious calculations. The graphical solution by C. A. Smith, which is to be found in "Kent," is hardly more feasible than these analytical solutions. Prof. J. F. Klein, of Lehigh University, however, has presented a graphical method, which is a modification of one originated by Prof. Culmann, and which is far superior to any of the methods previously mentioned. It has the advantage that it is theoretically accurate; but it has the marked disadvantage that the curve used has to be constructed from a series of ordinates, and then drawn in by means of a curved ruler. This method was thoroughly described by G. A. Goodenough, of the University of Illinois, in the *American Machinist*, October 29, 1896. Three other methods of considerable merit have come under the observation of the writer, which are very similar to each other, and are also similar to the method that is to be described in this article. The methods referred to are those of H. W. Spangler, Assistant Engineer United States Navy (*Journal of the Franklin Institute*, February, 1883); of Lucien E. Picolet, this being a modification of Spangler's method (*American Machinist*, February 18, 1904); and of Prof. W. K. Palmer, University of Kansas (*American Machinist*, July 14, 1898).

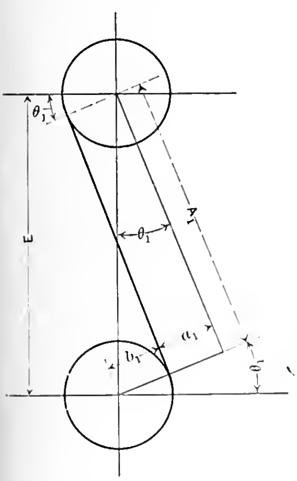


Fig. 1.

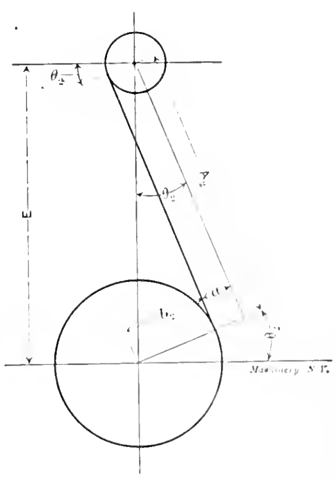


Fig. 2.

Having observed these various methods which appear to the writer to be of lesser merit, it has been a matter of some surprise to him that he has never seen advocated the elegant method presented by Dr. L. Burmester in his "Lehrbuch der Kinematik." Dr. Burmester's method is entirely graphical, and is exceedingly simple in application. While it is not theoretically exact, it is, as will be shown later, much more accurate than practice requires.

In order to bring out more clearly the points which will come up in the case of open belts, let us first consider the simple case of crossed belts. It is a well known fact that in this case the only calculation necessary in order to find the radii of the various steps is to make the sum of the radii of any two corresponding steps a constant. This may be shown in the following manner:

Notation:

a = radius of step, driving cone.

A = length of belt from contact on driving cone to contact on driven cone.

b = radius of step, driven cone.

E = distance between centers of cones.

K = a constant.

θ = angle shown, Figs. 1 and 2.

Note: A subscript applied to a letter denotes that the letter is the one used in the corresponding figure; thus, a_1 refers to a in Fig. 1.

Then

$$\sin\theta_1 = \frac{a_1 + b_1}{E} = \frac{K}{E}$$

$$\sin\theta_2 = \frac{a_2 + b_2}{E} = \frac{K}{E}$$

Therefore $\theta_1 = \theta_2 = \theta$, a constant.

Therefore the arc of contact on each pulley $= 180° + 2\,\theta =$ a constant.

$$\text{Also } \cot\theta = \frac{A_1}{a_1 + b_1} = \frac{A_1}{K} = \frac{A_2}{a_2 + b_2} = \frac{A_2}{K}$$

$$A_1 = A_2 = K \cot\theta, \text{ a constant.}$$

$$\text{But length of belt} = 2\,A + \frac{180° + 2\,\theta}{360} \times (2\,\pi\,a_1 + 2\,\pi\,b_1)$$

$$= 2\,A + \frac{180° + 2\,\theta}{360°} \times 2\,\pi \times (a_1 + b_1)$$

and, as has been shown above, all the terms are constant, therefore length of belt is constant.

The radii of the various steps may be determined graphically by the following diagram (Fig. 3):

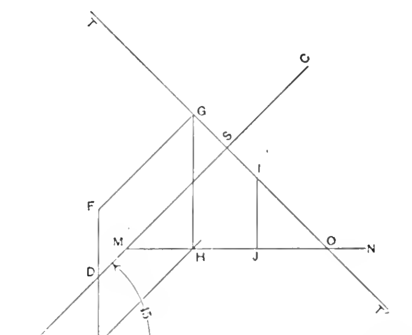


Fig. 3.

Draw the horizontal line AB, and from A draw AC making an angle of 45 degrees with it. On this line lay off AS equal to (E) the distance between the cone centers; using any scale most convenient, bearing in mind, however, that the scale adopted now must be used consistently throughout the diagram. At S erect the perpendicular TST' to the line ASC. From some convenient point on AC, as D, drop a vertical equal to some known radius of the cone A, as DE, and then from E measure back on this vertical the radius of the corresponding step on cone B, as EF, and from these points E and F draw lines parallel to ASC. From the point G, where the line FG intersects the line TST', drop a vertical. This will intersect the line EH in H. Through H draw the horizontal MN, O being the point where this line intersects the line TST'. Then, distances on the line MO may be taken to represent radii on cone A; and to find the corresponding radii on cone B erect perpendiculars at the extremities of these radii, producing them until they intersect the line TST'. These perpendiculars then represent the desired radii. It may be shown as follows that the sum of the two corresponding radii, as obtained from this diagram, is always a constant, and the diagram therefore satisfies the conditions for crossed belts.

Let MJ represent any radius on cone A, then JI represents the corresponding radius on cone B.

The $\angle JIO = \angle JOI = 45$ degrees.

Therefore $JI = JO$.

Therefore $MJ + JI = MJ + JO = MO$, a constant.

Dr. Burmester's diagram for open belts is a modification of the diagram just shown, the only difference being that the line TST' is replaced by a curve. This curve was determined by plotting a series of points, and after several pages of exceedingly intricate mathematics he arrived at the astonishing result that this curve could be replaced by a simple circular arc without any appreciable error.

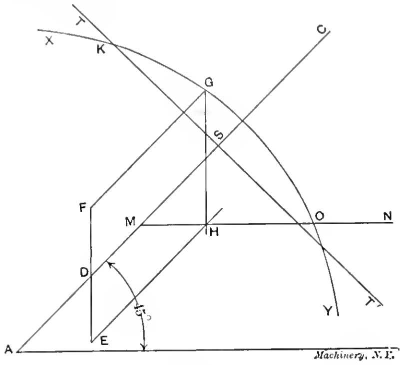


Fig. 4.

The diagram is shown in Fig. 4, and may be drawn as follows: Proceed as in Fig. 3 until the line TST' is drawn, then lay off SK equal to $\frac{1}{2} AS$ $(= \frac{1}{2} E)$. Next, with a center at A and a radius equal to AK describe the arc XY, and the diagram is ready for use.

In order to give an idea of the extreme accuracy of the diagram, let us observe the values obtained by Dr. Burmester in his calculations.

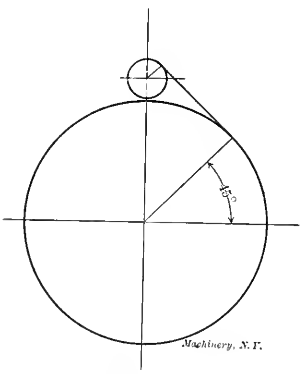


Fig. 5.

Let $R = AK$ (Fig. 4).

When $\theta = 0$, $R = E \times 1.11815172$.

$\theta = 15°$, $R = E \times 1.11806842$.

$\theta = 30°$, $R = E \times 1.11798671$.

$\theta = 45°$, $R = E \times 1.11803397$.

The value used for R in the diagram is $E \times 1.11803397$; so the maximum error of R occurs when $\theta = O$, and is equal to $E \times .00011775$, which is much more accurate than the work of the most careful draftsman. Dr. Burmester gives values of R up to $\theta = 90°$, but as it is evident from Fig. 5 that it would be practically impossible to have a value of θ greater than 45°, the writer has omitted the other values.

In order to make the use of the diagram perfectly clear, let us solve the following problems:

Problem 1. (Fig. 6).

Given:

Distance between centers of cones = 3′ 4″.

Diameter driving cone 4″, 8″, 14″, 20″.

Diameter driven cone X, X, 14″, X.

Required:

All diameters of driven cone.

Lay out the diagram and determine the point M as previously directed. Now the radii of driving cone may be laid off as abscissas or ordinates, whichever happens to be the more convenient, as the results obtained will be exactly the same in either case. In this particular problem it is evidently more convenient to lay them off as abscissas. Then the ordinates erected at the ends of these abscissas will represent the corresponding radii of the driven cone. The problem is solved in Fig. 6 and the following results obtained:

Results:

Diameter of driven cone 22½″, 19⅜″, 14″, and 7¼″.

This problem does not bring out all of the beauties of the diagram, so let us solve a more complicated one, in which the different steps of the cone are to transmit given velocities.

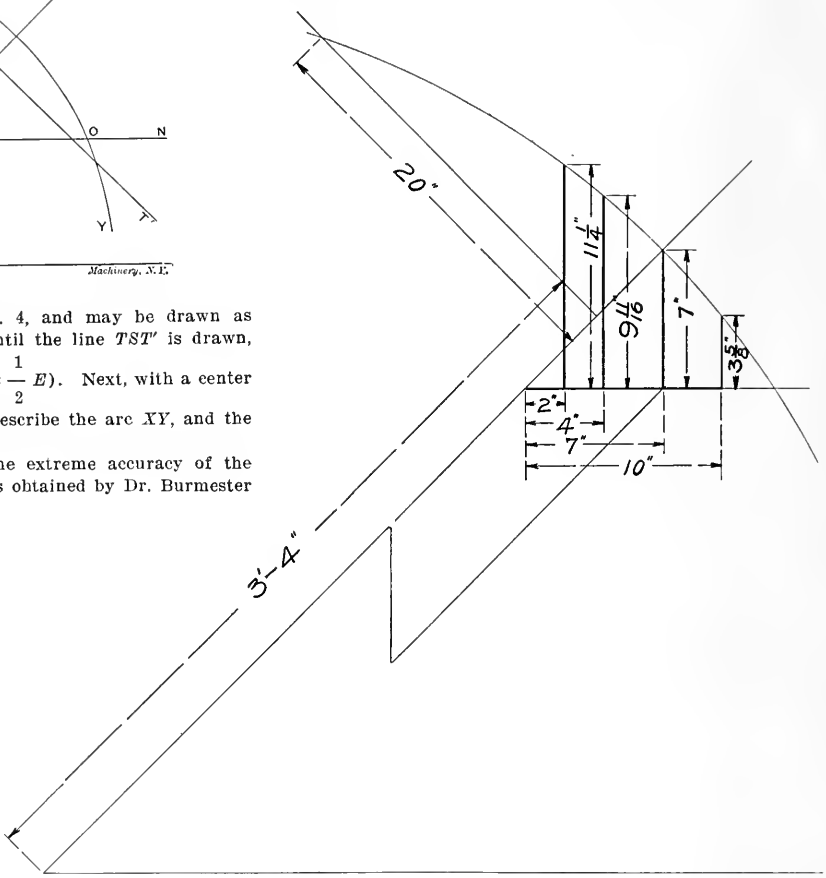


Fig. 6. Solution of Cone Pulley Problem when Diameters of one Pulley and Center Distance are Known.

Problem 2 (Fig. 7).

Given.

Distance between centers of cones = 3′ — 4″.

Maximum velocity of belt (assumed) 30 feet per second.

R. P. M. of driving cone = 240.

Required:

Driven cone to make 100, 240, 400 and 580 R. P. M.

The maximum belt speed will be attained when the belt is on the largest step of the driving cone.

$$\text{Therefore} \quad \frac{2 \pi a_1 \times 240}{12 \times 60} = 30$$

$$2a_1 = 28\tfrac{5}{8}''$$

$$\text{But} \quad \frac{2b_1}{28\tfrac{5}{8}} = \frac{240}{580}$$

$$2b_1 = 11\tfrac{7}{8}''.$$

Now having obtained a value for a_1 and b_1, the point M on the diagram may be found. Next draw a line from M as MO,

inclined so that any horizontal projection, as MN, will be to the corresponding vertical projection, NO, as the R. P. M. of the driver are to the R. P. M. of the driven; thus,

$$\frac{MN}{NO} = \frac{\text{R. P. M. of driving cone}}{\text{R. P. M. of driven cone.}}$$

Also from similar triangles

$$\frac{MN}{NO} = \frac{MN'}{N'O'}$$

But we know that

$$\frac{\text{R. P. M. of driving cone}}{\text{R. P. M. of driven cone}} = \frac{\text{rad. of driven cone}}{\text{rad. of driving cone}}$$

Therefore MN' equals radius of driven cone, while $N'O'$ equals radius of driving cone, thus making, for this case, radii of driving cone vertical and of driven cone horizontal. The problem is solved in Fig. 7 and the following results obtained:

Results:

Dia. of driving cone 28⅝", 25⅝", 20¾", 11⅞".

Dia. of driven cone 11⅞", 15⅜", 20¾", 28⅝".

We have seen that the Burmester diagram is under all conditions much more exact than is required in practice; and a more compact, simpler, or quicker method of finding cone pulley radii could not be desired. An experienced draftsman should be able to solve a problem like No. 2 above in less than 10 minutes, while to obtain the same results by an analytical method would require as many hours. Results of sufficient accuracy can usually be obtained by making the diagram to half scale, although there is no reason for reducing the scale, unless the distance between centers is inconveniently large, and in that case the results do not need to be so accurate as the belt will stand more stretching.

* * *

INSTRUCTIONS FOR DRAFTSMEN.

EDWIN W. BEARDSLEY.

The following instructions are intended to be, for the most part, or with minor changes, applicable to the practice of the average drafting room, and, for that reason, are usually confined to principles. Disagreement will often be found with those which are not principles, but they represent excellent practice. They are very largely the result of notes made from time to time for several years as I have seen the needs when checking drawings. I have tried to condense as much as possible into few words, but my object has been to require but a few minutes to hurriedly read the whole and to thus make it easier for a beginner to read them every day, or a tired checker to glance them through, occasionally, for pointers that might have slipped his mind.

DETAIL DRAWINGS.

Scale.

Make details to a scale large enough to distinctly show all parts and also to give sufficient room for necessary dimensions. This will sometimes require two or more times actual size. Do not use an unnecessarily large scale when it will also require a larger sheet than is necessary.

Views.

The views required are those necessary for completely and plainly showing the piece—no more, no less—except that one view is sufficient if another would show no more than is given by "4" dia.," "¼" thick," etc., on the one view.

Show pieces in the position they occupy on the construction drawing or on the completed work, when there is no disadvantage in doing so.

Do not leave wider "open" spaces between the several views of one piece than between those and the views of nearby pieces. Do not crowd views so closely together that there will not be sufficient room for dimensions and notes.

Show long pieces, with a portion of the length broken out when a larger scale than full length would allow is desirable, but do this only when a continuous portion of parts fully shown is thus broken out, or when notes fully explain the omitted portion.

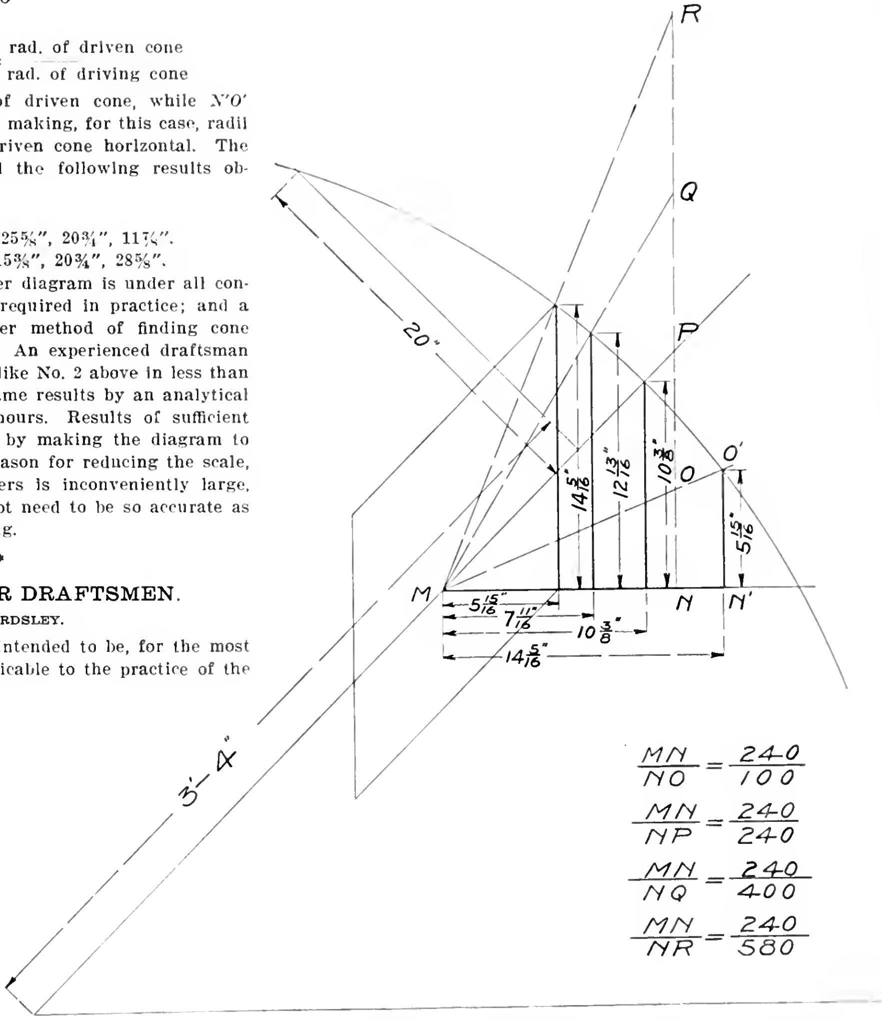


Fig. 7. Solution of Cone Pulley Problem when Desired Velocity Ratios, Maximum Belt Speed, Center Distance and R. P. M. of Driver are known.

A part of a view may be shown when the remainder would be only a repetition of what is plainly shown elsewhere.

Always use "third angle" projection; that is, place views nearest the side of adjoining view which they show. Follow the same principle of direction of view in sections, making them on the side where the outside view of the cut-away portion would be. Any deviation from this rule must be very plainly noted on the drawing.

Always draw both right-hand and left-hand pieces when both are to be made unless the differences are so simple that one or two dimensions can be noted for each without confusion. If the pieces are castings and but one pattern is required, make notes to that effect, mentioning changes. This also applies to similar pieces cast from one pattern with changes, when a detached view, or portion of one, would often show the change.

Lines.

Make outlines in medium or heavy lines, giving strong contrast with dimension and center lines, which must always be light but distinct.

Make section lines not less than 1-16 inch apart, except on widths of less than ⅛ inch. Make them lighter than the outline. On ordinary work, narrow sections may be hatched free-hand.

Have no "hair" lines in figures, letters or outlines.

Do not make the line which shows an obtuse angle corner as heavy as the outline.

Dimensions.

Give all the dimensions necessary to make the piece—no more, no less—and do not repeat on same nor on different views of the same piece unless for a special reason.

Give dimensions so that the workman will not have to do any important figuring himself.

Give dimensions where and as they will be most useful to the workman.

Do not give dimensions from the center line of a piece when it is not necessary.

Give dimensions from something that the workman can and should measure directly from, if reasonable to do so.

Give dimensions between places having a definite relation rather than otherwise.

Place the shorter dimensions nearest the outline.

Place dimensions so that there need be no doubt as to what they refer.

Do not repeat a dimension many times in a single line where the likeness is clear from the drawing. At most, give it two or three times and then include the remainder, or the whole, in a dimension reading like this: 12 spaces at 9″= 9′ — 0″.

Never crowd dimension lines or figures.

Run the limiting line slightly beyond the end of the dimension line.

On a piece having several diameters in its length, or in similar holes, give the diameters on side view, or section, rather than on end view.

Where two things are centrally spaced in relation to a third, and also definitely related to each other, give one dimension from the center to one and another between the two.

Where an inside dimension is given on an outside view and is not much different from it, make distinct by marking "inside," or by giving, in line with it, the remaining dimension.

Do not call for impossible or unnecessary accuracy. If a dimension is calculated 18 1-64 inches and the work is so rough that inaccuracies of 1-16 inch are provided for, leave off the 1-64 inch, but do not disregard the correct figure in further calculations.

When a dimension is not to scale and piece is not shown broken, mark the dimension "make."

Give angles from existing surfaces, or, so that no figuring will be required of the workman in order to measure the angle.

Make the dimension line for an angle an arc with its center at the vertex of the angle. Mark figures "deg." and "min." Do not use their signs.

Mark radii "rad," or "R."

Place dimensions in the space, and reading in the direction to which they apply when greater distinctions or convenience would not be obtained otherwise. When the space is too small for the figures place them nearby and in such relation that they cannot be misunderstood. Usually an arrow is required running to the space.

Figures and Signs.

Never put letters, figures, signs or arrowheads on, nor running into, each other, the outline of the piece nor any but their own dimension lines.

Make figures and lettering read from the bottom or from the right-hand end of the sheet, always parallel with one or the other, except dimensions on lines necessarily on an angle and on radii and the degree measuring angles, which may read on an arc of the angle.

Make figures and letters large enough and heavy enough to be distinct—not less than 5-64 inch or 1-12 inch high on ordinary work. That size for fractions and ⅛ inch to 5-32 inch for whole numbers is good practice.

Make the dash between feet and inches distinct so that 3′—4″ shall not be mistaken for 34″.

Make arrowheads plain and neat. Make them blunt if there is danger of doubt as to the line they designate.

Use open and distinct forms of figures and letters.

Make inch and foot marks distinct, but much smaller than the figures.

Make whole numbers by fractions large enough that they will not be mistaken for a part of the fraction.

When space is not necessarily limited in height, use the horizontal vinculum, or separating line in fractions: $\frac{1}{2}$ rather than 1/2″.

Notes and Lettering.

Put notes on the drawing whenever necessary for a distinct understanding of the requirements, as when one part is to have a certain fit with another, except where same is otherwise provided for, as by gages, micrometer measurements, or in some cases it may be by the construction drawing.

Express things in notes whenever they will be plainer that way than by further drawing or dimensions.

On rough work it is often well to note character and use with size of holes, thus: "drill 17-32″ for ½″ bolts," "punch 9-16″ for ½″ bolts," "core ⅝″ for ½″ bolt," "ream for ½″ shaft," "bore for sleeve No. 65."

When there might be a question about them, mark cast holes whether cored or cut in pattern.

On work having little finishing, mark such surfaces finish, bore, drill, turn, etc.

Run leading lines from notes to holes or other features to which they apply, unless their relation is very plain. Make them free-hand, light, with black ink and an arrowhead at the end indicating unmistakably to what it refers.

Avoid words and phrases which might be easily misunderstood, or not understood at all.

When a note consists of more than two lines, make them match, vertically, on the left-hand side.

Make spacing between lines of lettering in notes uniform and not wider than the height of the letters.

Except in simple cases, name the sections of a piece and show by a light broken line where they are taken. Letter the ends to the line to read from the side that would be removed to show the section as drawn.

Make all lettering in capitals, vertical, or very slightly inclined to the right and of uniform height.

Make titles, names of sections, views and pieces with letters ⅛ inch high, other lettering 1-12 or 5-64 inch high.

Never dot capital I.

General.

Exercise your "gray matter" a little before doing things rather than "the boss's" patience afterward.

A rule is sometimes best observed in the breaking rather than the keeping. Heed the spirit as well as the letter of all instructions.

The men who make the pieces are not draftsmen and should not be supposed to know more about a piece than is given on the drawing.

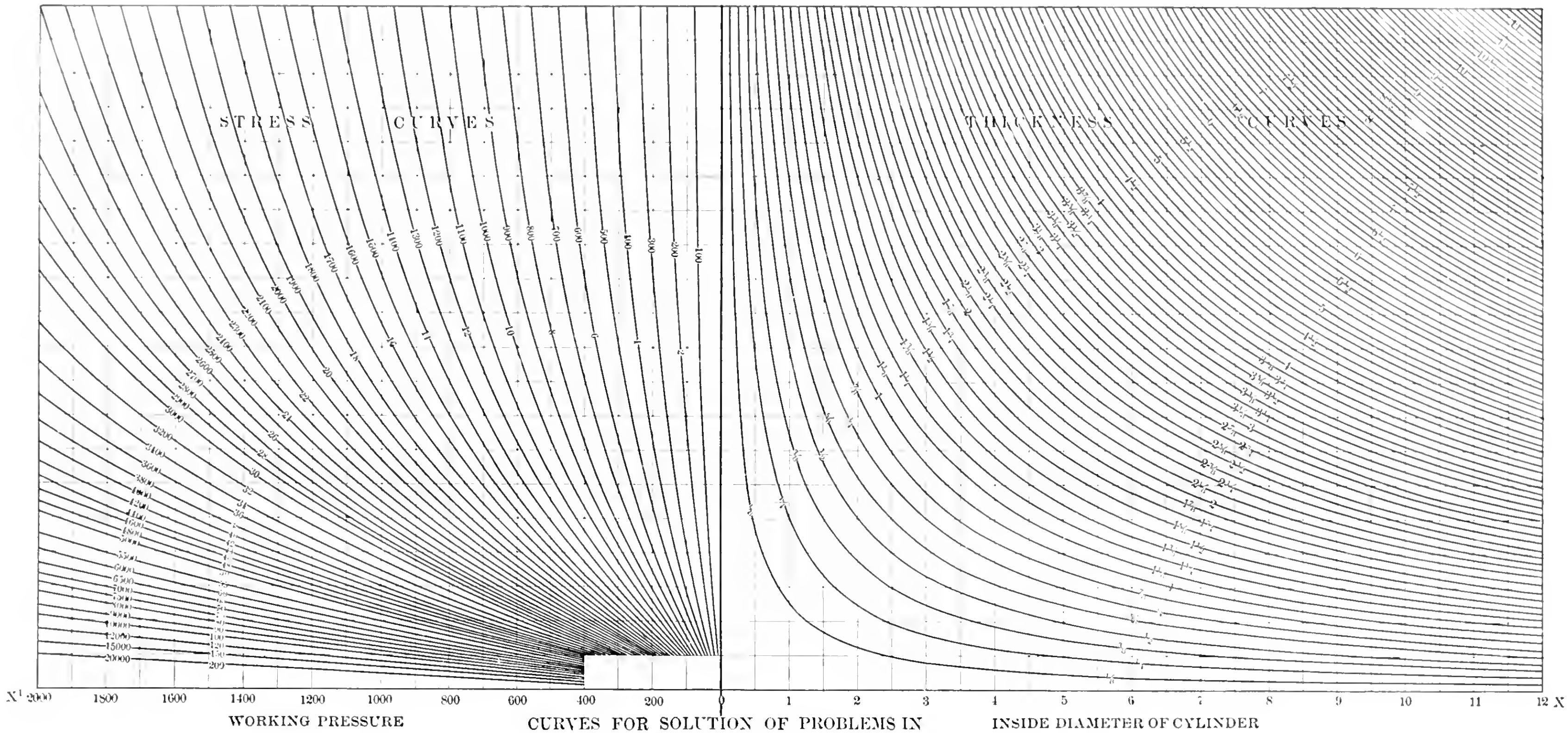
A drawing is plainer to the man who makes it than to the mechanic who first sees it when he is started on the work. Consider what you would want to know if you were to make the piece correctly under the workman's circumstances.

Strive for clearness, completeness, simplicity and neatness.

* * *

Mention was made in these columns some time ago of a technical dictionary which is in course of preparation by the Society of German Engineers. We have received from them a short report of the progress they are making in the work. It will be remembered that this dictionary is to include the technical and trade vocabulary of the English, German and French languages. The report states that up to June, 1905, they received 2,700,000 word cards from about 2,000 firms and individual collaborators at home and abroad. To these will be added the hundred thousands of cards that will result from the working out of the original contributions not yet taken in hand.

The Editor-in-Chief will be pleased to given any information required in regard to this work. Address Technolexicon, Dr. Hubert Jansen, Berlin (N. W. 7), Dorotheenstrasse 49.



CURVES FOR SOLUTION OF PROBLEMS IN DESIGNING THICK CYLINDERS

THICK CYLINDERS.

JOHN S. HOLLIDAY.

The thickness of wall in cylinders for high pressure must be determined partly from experience. In all cases a large factor of safety must be employed to allow for imperfections in the metal, strains due to outside causes, etc. In the determination of the factor of safety, the designer must be guided by current successful practice.

The most generally accepted formula for the thickness of wall is that of Lamé. It is as follows:

$$t = \frac{d}{2}\left(\sqrt{\frac{S+P}{S-P}} - 1\right) \qquad (1)$$

in which

t = thickness of wall in inches.
d = inside diameter of cylinder in inches.
P = working pressure in pounds per square inch.
S = stress in cylinder wall in pounds per square inch.

(For the derivation of Lamé's formula, see Thurston's "Iron and Steel," page 452; Rankine's "Applied Mechanics," page 290, or Burr's "The Elasticity and Resistance of the Materials of Engineering," pages 19 and 895.)

If S is taken as the ultimate tensile strength of the material, the thickness found will be that which would just be ruptured by the given working pressure. To find the actual thickness the ultimate tensile strength must be divided by the factor of safety.

The accompanying set of curves has been devised to save the time and mathematical work involved in the solution of problems by Lamé's formula. By means of these curves any one of the four quantities may readily be determined when the other three are known.

To prepare the curves the formula was put in the form

$$\frac{R}{r} = \sqrt{\frac{S+P}{S-P}} \qquad (2)$$

in which

R = the external radius of cylinder.
r = the internal radius of cylinder.

(This is done by substituting r for $d/2$ and $R - r$ for t and then dividing by r.)

It will be seen that the value of the ratio R/r is independent of the diameter. For convenience, denote the value of this ratio by K. The formula then becomes

$$K = \sqrt{\frac{S + P}{S - P}} \qquad (3)$$

The values of the inside diameter, d, are platted along $O X$ and values of the working pressure, P, are platted along $O X'$. Values of the ratio R/r are platted along $O Y$ beginning at unity instead of at zero. The values 100, 200, etc., are then substituted for S in (3) and the resulting curves between K and P are platted to the left of $O Y$. These curves represent stress in wall of cylinder.

Since $t = R - r$ and $R = Kr$, we have

$$t = Kr - r$$
$$= r\ (K - 1)$$

and therefore $2t = d\ (K - 1)$.

This equation is of the form $xy = C$. The values 1/8, 1/4, etc., are then substituted for t and the resulting curves between d and $(K - 1)$ are platted to the right of $O Y$. These curves represent thickness of wall.

The use of the curves may best be shown by a few examples.

Example 1: $d = 5$ inches, $S = 1{,}600$ pounds per square inch, $P = 700$ pounds per square inch; find t.

Solution—From point 700 in $O X'$ follow vertically upward to the stress curve marked 1,600, then horizontally to the right to the vertical line from point 5 in $O X$. The intersection falls nearly on thickness curve marked 1 1/2. The required thickness is therefore 1 1/2 inch.

Example 2: $t = 2$ inches, $d = 8$ inches, $P = 1{,}000$ pounds per square inch; find S.

Solution—From point 8 in $O X$ follow vertically upward to thickness curve marked 2, then horizontally to the left to the vertical line from point 1,000 in $O X'$. The intersection falls on stress curve marked 2,600. The required stress is therefore 2,600 pounds per square inch.

Example 3: $t = 1\frac{3}{4}$ inch, $S = 1{,}200$ pounds per square inch; $d = 8$ inches; find P.

Solution—From point 8 in $O X$ follow vertically upward to thickness curve marked 1 3/4, then horizontally to the left to the stress curve marked 1,200, then vertically downward to $O X'$, where we find the required stress, which is 420 pounds per square inch.

From (1) it will be seen that if t and d are both multiplied or both divided by the same number the values of S and P will not be affected, and likewise if S and P are both multiplied or both divided by the same number, the values of t and d will not be affected. By this means the use of the curves may be extended.

Example 4: $t = 4\frac{1}{2}$ inches, $d = 30$ inches, $P = 600$ pounds per square inch; find S.

Solution—Divide t and d by 3, giving $t = 1\frac{1}{2}$ and $d = 10$. Then, solving as in example (2), we find the required stress to be about 2,340 pounds per square inch.

Example 5: $d = 3\frac{1}{2}$ inches, $S = 5{,}000$ pounds per square inch, $P = 3{,}000$ pounds per square inch; find t.

Solution—Divide S and P by 2, giving $S = 2{,}500$ pounds per square inch and $P = 1{,}500$ pounds per square inch. Then, solving as in example (1) we find the required thickness to be 1 3/4 inch.

If a problem involves the use of the small rectangular space where the stress curves are not produced it may still be solved if S and P are multiplied by some number which will make P greater than 200 pounds per square inch.

* * *

THE DRAFTSMAN AND HIS WORK.*

Gentlemen—Your superintendent wanted me to come down to-night and give you a few words on the above subject. Now, if he could have reversed this operation and sent you boys all around to the shop instead of having me come here, I think we could have done the subject justice, for while I have the highest respect for the draftsman, I never could get accustomed to his environment. Many a time have I seen the foreman of the drafting-room gently place a sheet of blotting-paper beneath my elbow, when, absorbed in the problem we had before us, I have thoughtlessly placed it on his spotless sheet. But, as we should always make the best of the situation, we will try to do so in this case.

* Extract from an address before a body of draftsmen.

First, I wonder how many of you realize why you are here, or that in coming here you have taken the first step on the ladder that leads upward, for while thousands of men have passed through the shop into the drafting-room and beyond, seldom do we hear of a draftsman going back into the shop, except it be to supervise the work of others.

Perhaps I cannot do better than to give you a few illustrations of how the experience which a man gets in the drafting-room gives him the ability to get out of a cavity, when he is called upon to do so. The first is one that happened only a short time ago in this city:

They had just got a new smith; he was a good workman and could turn out a fair amount of work. One day the foreman took out a drawing of a piece of work for him to do. It was about three inches wide and ten feet long; too long to be shown the full length on the paper, so each end was drawn and the center broken in two with that jagged line we all know so well. The smith looked it over and said: "Well, I can make those ends all right, but who is going to cut in those saw teeth, me or the machinist?" Well, he didn't stay long, and as you can see, a little knowledge of drafting would have been worth dollars and cents to him at that time.

There is another friend of mine who goes down South, laying out plans for the big cotton mills; that is, he goes to the mill, takes the plans, and lays out the floor space for the machinery. He was down there on a job, miles away from any machine shop, and one night they came over from the other mill and told him of a scrape they had gotten into. They had ordered a piece of 6-inch shafting, 16 feet and 9 inches long, and by some error it had come 19 feet and 6 inches long. As it was intended to go down in the basement of the mill, it was not possible to use it on account of the extra 3 feet. Could he do anything for them? It was one hundred miles from any shop that could handle a shaft of that size. Jack thought it over a moment, thought what tools he had in his kit, and said: "Yes, I guess I can." Well, how long would it take? "Give me four good darkeys and you shall have it at seven o'clock in the morning—that is if you give me good men."

Well, Jack got his four men and he started in. He had a 12-inch saw frame in his kit and plenty of blades. First, he put a collar on the shaft, even with the place he wanted to cut off, and then he started in the first man and had him saw fifteen minutes, then changed him off for number two and so on. He let each man work fifteen minutes and lay off forty-five minutes. He kept it up in this way all night, and just as the whistle blew at seven the next morning the shaft was off. The mill superintendent was more than pleased, as his entire mill was shut down until the shaft was in place.

Another job that was done by this same man will, I think, interest you. Jack was sent out by a firm to put a large drum on a water-wheel shaft, 'way up in the Maine woods. It was miles away from anywhere. The drum had been bored out in the shop to fit a wire sent down from the mill, and he got the drum there and started it on to the shaft. It went all right to within about three feet of the place where it was wanted. There was a bunch on the shaft just where Jack didn't want it. What was to be done now? He started in with a file, but to take one thirty-second of an inch from a six-inch shaft is no joke, and Jack wanted to start back home that day. He took a four by four joist about ten feet long, stuffed it through the drum and blocked each end to prevent it from turning. He put a small rope fall at one end to pull the drum on with, and a chain fall at the other to prevent it going too fast, then, sprinkling the whole length of the shaft with oil and sand, he started the water wheel and ground away. It worked all right until he got within three inches of where it was wanted, and then the drum "seized" on the shaft, and brought the mill up, all standing. The keyway in the shaft and drum didn't line, but that didn't worry him any. He left the key with the

foreman and told him if the drum ever got loose he could put it in, but "if you ever want to take it off, don't send for me."

Your superintendent wanted me also to say a few words to you on dies and press tools. I spent a good deal of time in the Public Library of Boston and elsewhere, and found out a number of things that were interesting in that line, and while we must give the Germans credit for the origin of presses and dies, it was the French mechanics who were the ones to put them in practical every-day use.

In the year 1796 a patent was granted to one De Vere of France for press tools for both punching and drawing of sheet metal, and in 1827 patents were granted for the same class of work in this country. In 1859 two French workmen came to this country, bringing with them a wooden model of a drawing press. This had been made from drawings which they had surreptitiously taken from a press which they had been engaged in making. This press was stored in a barn at Wilmington, Delaware, and capital was obtained to form a company to build and operate the same, known as the Higgins & Marchand Company.

The press was a single-action cam press, the cam being used to force the drawing punch through the die; the blank being held down by a three thousand pound weight, which was worked by a sixteen-foot lever extending out through the wall of the shop, the weight being on the outside. The first piece of work drawn up was a wash-basin, and was made from a fourteen-inch blank. This was probably the first piece of drawn work ever made in America.

There is one thing that the draftsman invariably gets left on, and that is getting the length of the piece to be bent in the die. He always gets it too long. The rule usually followed is to take the center line of the stock; that is, if you have a piece of metal to bend, you allow one-half the thickness for every bend you make, and while this is all right in theory there is a certain amount of stretch beside this, and I never remember seeing a draftsman figure out a piece and get it too short. A safe way is to put a note on the drawing for the tool-maker to make the bending die first; it is the only safe way. I had the pleasure (?) some time ago of working up several tons of stock where they had made the blanking die first, and had gone ahead and blanked out the parts without waiting for the bending dies. It is needless to add that no drafting was done on the job, but it would have been money well spent if they had done so.

It is not necessary for me to say anything on the subject of drafting for tool work. A large manufacturer in this city, and one whom you all know well, said to me a few days ago: "I used to build all my tool work on the cut-and-try method, but now not a stroke of work is done until drawings are made, and I want the best man I can hire, too. It is a lot easier to change tools on paper than it is in hard steel."

One thing more and I will finish, and that is, whatever branch of drafting, or in fact anything else you take up, take up one thing and learn it thoroughly. It doesn't make any difference what that thing is; it may be brick machinery, sewing machine needles or steam turbines, or air ships; learn it well and you will always find a market for your goods.

J. L. Lucas.

* * *

INDEX SYSTEM

FOR DRAWING-ROOM IN SHOP WITH GREAT VARIETY OF WORK.

From time to time there have been published in Machinery articles concerning index systems for the drawing-room; being deeply interested in this subject myself I have read these articles with much care. However, the articles I have seen hitherto have related to drawing-rooms in shops where the product has been limited to only a few standard articles, which have been turned out in great quantities. Thus, not having been able to find an outline of a system that would suit the particular conditions under which I am working, I have been obliged to devise for myself a system specially adapted to a drawing-room in a shop with a great variety of work. As no doubt there are many of the readers of Machinery who have had trouble keeping in order the vast number of drawings, sketches, patterns and such tools as the drawing-room often is expected to keep track of, I have outlined below a system which I have devised and tried, and which I am at present using to good advantage.

At first glance the system might seem somewhat elaborate, but a little extra expense added in the beginning will more than repay itself in the long run. The main factor to be taken in consideration when planning a system is of course the rapidity with which a thing looked for can be found. The somewhat greater care needed to keep up a complete system will hardly amount to anything compared with the time wasted in trying to locate things looked for in an incomplete and patched up system.

The words, "drawing," "shop sketch" and "customer's sketch" referred to below are defined in this system thus:

1. *Drawing.*—Any tracing or drawing for machines, tools and devices manufactured by the firm as a standard article or used in the shop.

2. *Shop sketch.*—Any drawing, made in the drawing-room, of special tools that are ordered in small quantities by customers.

Customer's sketch.—Any drawing, tracing, sketch or blue print that has been sent to the firm by outside parties or customers.

Drawings are indexed on cards on which is stated—

1. Number and letter of drawing (the letter indicating the size of the drawing).
2. When made
3. By whom made.
4. By whom checked.
5. Complete title of the drawing.
6. Piece number (if a casting this is also the pattern number).
7. Remarks.

Drawing No. A-612 **Date** March 6 1905
Drawn by M. C-r **Checked by** Potter

Casting Detail:
Special head for #2
Brown & Sharpe Milling Machine.
Piece No. 656
Remarks: For construction see A-109.
For milling hexagon nuts.

Fig. 1. Index Card for Shop Drawing.

These cards are numbered, when they are blank, with the drawing numbers in rotation, and are kept in numerical order. As soon as a drawing is made the first blank card is filled out and its number stamped on the drawing. The card is then placed in the index according to the following rules: In the first place, tools and machines should be indexed in general classes, and all general attachments for the machines should be indexed under the heading of the machine with which they are used. For example, cutters of every description should be indexed under the word "Cutter," and subheadings should be provided in the index if the number of cutters of different descriptions make a sub-division necessary. Again, for example, "Dividing head for milling machine" should be indexed under "Milling Machine" and subdivisioned under "Head." Sketch No. 2 of an index arranged in this manner will make further explanations unnecessary.

Jigs and fixtures that are to be used for certain operations in manufacturing parts of standard machines and tools are indexed in the same divisions as the parts on which the operation is to be performed is indexed under, for example, the fixture for boring head for milling machine is indexed under "Head" for "Milling Machine." In cases where it is found difficult to decide under which heading to place a certain tool or fixture, it is advisable to make out two or even more cards under such headings where they are most likely to be looked for. The files for the cards should be kept in the

most accessible place in the drawing-room, where everybody having to use them can do so with convenience.

The drawings are filed in drawers in the drawing-room, but a "record blue-print" of each ought to be kept in a fireproof safe or vault; of course one must be very particular about replacing these "record blue-prints" every time a change is made on the original tracing or drawing.

Sketches, as a rule, being used only a very limited number of times, ought not to be traced but drawn either in copying ink or copying pencil, and copied in a special copybook used

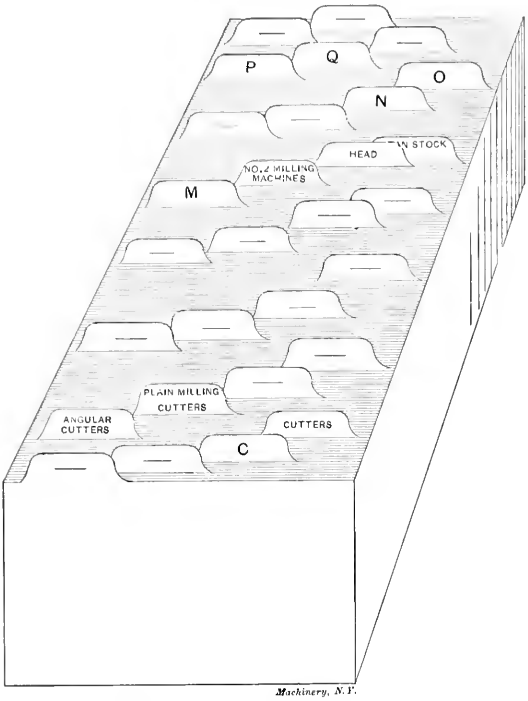


Fig. 2. Arrangment of Index Cards on File.

for the purpose. The sketch is marked with the page number of the copybook where it is copied. These sketches could of course be indexed on the index pages of the copybook, but when one copybook after another is filled out it would be a waste of time to have to go through the index of each one in order to find what is wanted; therefore a card index is provided for these sketches also where the cards are put in order according to the names of the customer.

No. of copybook 6 **Page** 314 **Date** March 12 1905
Drawn by G. R. **Checked by** Potter
Customer's name: American Tool Works Co., Cincinnati, Ohio.
Tool: Taper Reamer
Remarks: For Brass--made to their sketch.

There is also an additional card index for these sketches where the cards are put in order, not with reference to name of customer but according to name and kind of tool drawn on sketch.

Customer's sketches are not listed in any card index, but are kept in proper order in a common letter-file.

There is no need of providing for a card index for the patterns, as the pattern numbers are always marked, not only on the drawing itself but also on the index card for the drawing in question. However, it is both convenient and necessary in many cases to be able to tell from the number of the pattern what machine or tool this pattern applied to; therefore a book is provided with pattern numbers in rotation, where the patterns are entered as soon as a drawing is made.

It is not only necessary to keep a good record of drawings or patterns that have been made, but equally as important to have a complete record of blue-prints, sketches, patterns, etc., when in use. All blue-prints given out from the drawing-room must be charged to the person for whose use it is furnished, whether he be someone in the shop or an outside party. For this purpose there is a special set of cards, one card for each drawing, this card being provided with the drawing number; these cards are kept in numerical order. When a drawing is given out by the drawing room, the name

No. of Copybook 6 **Page** 314 **Date** March 12 1905
Drawn by G. R. **Checked by** Potter
Tool: Taper Reamer.
Customer's name: American Tool Works Co., Cincinnati, Ohio.
Remarks: For brass--made to their sketch.

of the person for whose use the drawing was given out is recorded on the card with the same number as the drawing. This enables anyone to find at a glance where every blue-print of a certain drawing can be found.

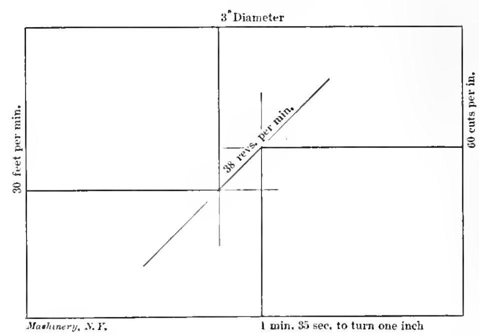
When sketches are sent out in shop, it is noted in the copybook itself on corresponding page, to whom and on what date, sketch was given out. As these sketches have to go from one department to another each department foreman is expected to keep a record of when and to whom he sent the sketch, when he was through with it. When the work is finished the sketch is returned to the drawing-room and the date when it was returned is noted down in the copybook on page number corresponding with sketch. Customer's sketches are never sent out in the shop, but are kept as records and for reference in the letter-file mentioned above.

A system laid out and made up in accordance with the principles above will prove itself very satisfactory, not to say necessary, for the drawing-room in a shop having a great variety of work to do. "A."

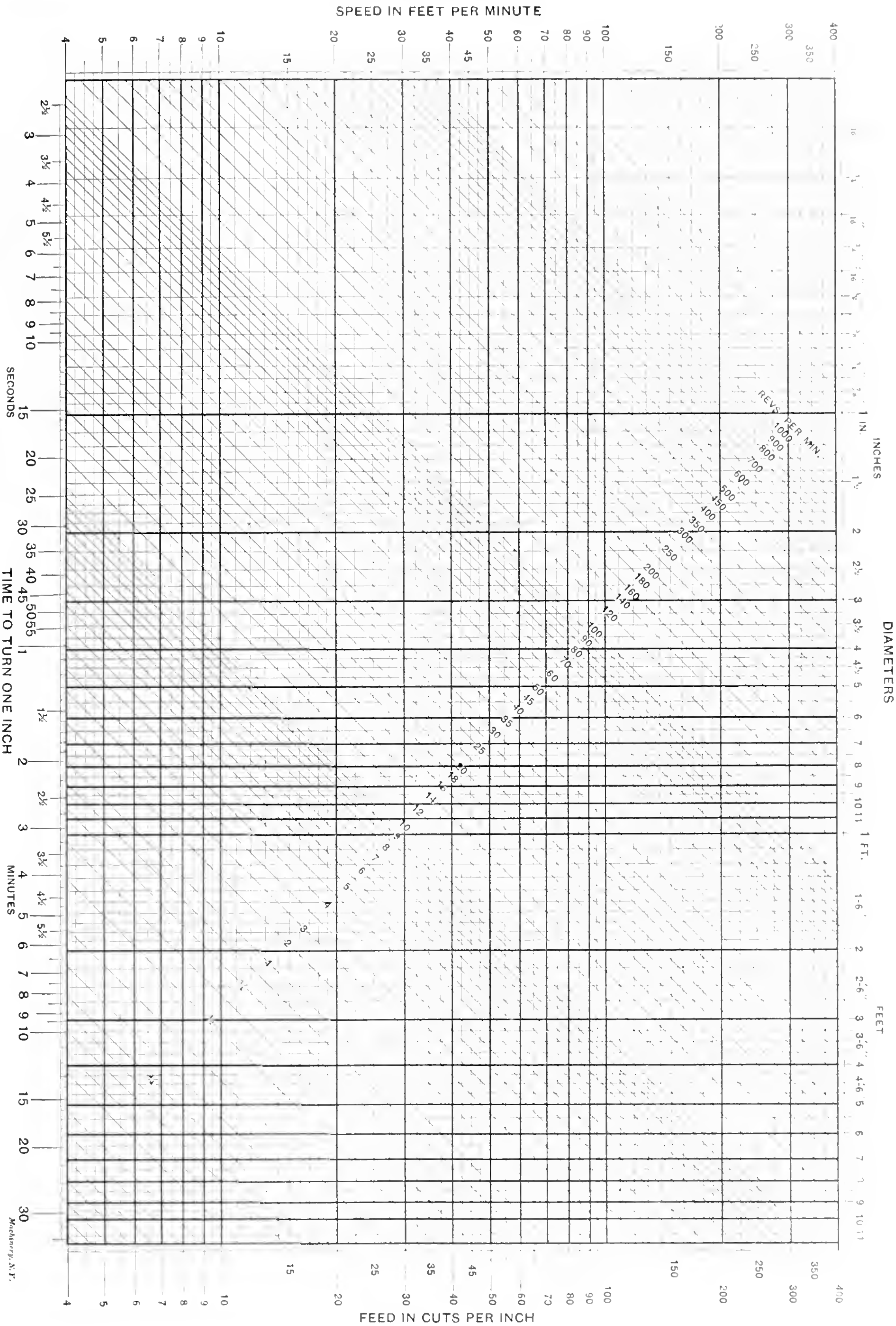
* * *

DIAGRAM FOR COMPUTING THE TIME TO TAKE LATHE CUTS.

On the opposite page will be found a diagram from which the time to take a given cut in the lathe may be estimated when the diameter of the work, the feed in turns per inch, and the surface speed or revoultions per minute are known. As shown in the cut below, follow the vertical line representing the desired diameter down to its intersection with the horizontal line which represents the desired surface speed;



follow the diagonal nearest this point, up or down, until it meets the horizontal line corresponding to the desired feed as read from the left of the table. A vertical line dropped from this intersection will show on the scale at the bottom the time it will take to turn one inch under the given conditions. This diagram was contributed by A. Thompson, of Birmingham, England.



Machinery, N.Y.

Diagram for Solution of Problems in Estimating Length of Time for Lathe Work.

BEVEL GEAR CHART.

GEORGE J. PORTER.

Some time ago I had occasion to lay out and find the necessary data for a pair of bevel gears where the shafts were not at right angles, and, as the formulas that I had at hand were only for cases where the shafts were at right angles, I looked through several standard treatises on gearing for something to help me out. Not finding anything, I worked out some formulas for myself to cover cases where the shafts were at less than right angles and greater than right angles. Since then I have prepared the accompanying chart and thinking that it might interest some of the many readers of MACHINERY, I send it to you.

Perhaps the best way of explaining the chart so that the reader may become familiar with it will be to work out an example in each of the three cases, using gears of the same pitch and number of teeth in each, so that a comparison of the results may be made and the differences of the face angles and outside diameters noted.

We will take for our examples gears of 12 and 18 teeth, 8 pitch and running with shaft axes at angles of 60 degrees, 90 degrees and 120 degrees respectively. Knowing the desired pitch and number of teeth, and, of course, the pitch diameter, the first thing to do is to find the center angles of the gears, and we will for convenience find that of the smaller gear first, and if we arrange our data as it is worked out, in some such form as that shown below perhaps it will help in making things clear.

Example 1: Shaft Angle, 60 degrees.

	Larger Gear.	Smaller Gear.
Pitch	8	8
Teeth	18	12
P. D.	2.25″	1.5
Center angle	36° 35′	23° 25′
Face angle	40° 22′	27° 12′
O. D.	2.451″	1.729″
No. of cutter	5	8

Example 2: Shaft Angle, 90 degrees.

	Larger Gear.	Smaller Gear.
Pitch	8	8
Teeth	18	12
P. D.	2.25″	1.5
Center angle	56° 19′	33° 41′
Face angle	61° 36′	38° 58′
O. D.	2.389″	1.708″
No. of cutter	4	7

Example 3: Shaft Angle, 120 degrees.

	Larger Gear.	Smaller Gear.
Pitch	8	8
Teeth	18	12
P. D.	2.25″	1.5
Center angle	79° 6′	40° 54′
Face angle	85° 20′	47° 8′
O. D.	2.297″	1.689″
No. of cutter	2	7

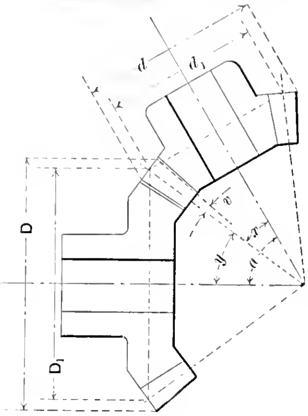


Fig. 1.

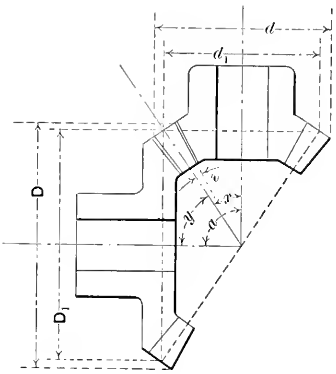


Fig. 2.

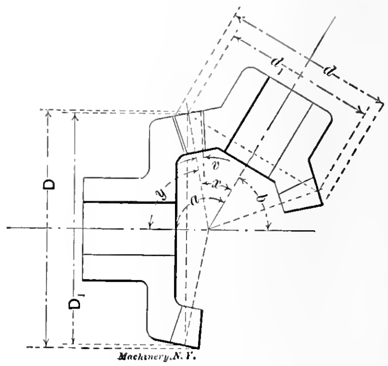


Fig. 3.

Larger Gear.

D = outside diameter.

D_1 = pitch diameter.

y = center angle and also angle of back cone radius measured from line perpendicular to axis of gear.

R = pitch radius $= \dfrac{D_1}{2}$

N = number of teeth.

Smaller Gear.

d = outside diameter.

d_1 = pitch diameter.

x = center angle and also angle of back cone radius measured from line perpendicular to axis of gear.

r = pitch radius $= \dfrac{d_1}{2}$

n = number of teeth.

a = angle of shafts.

b = supplement of shaft angles $= 180° - a$.

D_2 = working depth of tooth.

v = angle increment.

Fig. 1.

When shafts are at less than right angles.

$$\tan x = \frac{r}{r \times \cot a + \dfrac{R}{\sin a}}$$

Fig. 2.

When shafts are at right angles

$$\tan x = \frac{n}{N}$$

Fig. 3.

When shafts are at more than right angles.

$$\tan x = \frac{r}{\dfrac{R}{\sin b} - r \times \cot b}$$

$$y = a - x$$

$$\tan v = \frac{\sin x}{\dfrac{n}{2}}$$

Face angle of larger gear $= y + v$.

Face angle of smaller gear $= x + v$.

$D = D_1 + (D_2 \times \cos y.)$

$d = d_1 + (D_2 \times \cos x.)$

Number of teeth to select cutter for larger gear $= \dfrac{N}{\cos y}$

Number of teeth to select cutter for smaller gear $= \dfrac{n}{\cos x}$

In the first example, referring to Fig. 1 on the chart, $r =$ 0.75 inch, $a = 60°$; $R = 1.125$ inches, $\cot a = 0.57735$ and $\sin a = 0.86603$; now stating the formula,

$$\tan x = \frac{0.75}{0.75 \times 0.57735 + \dfrac{1.125}{0.86603}} =$$

$$\frac{0.75}{0.433 + 1.299} = \frac{0.75}{1.732} = 0.43303 = \tan\ 23°\ 25'.$$

Now referring to the chart, the center angle y of the larger gear $= a - x = 60° - 23°\ 25' = 36°\ 35'$.

The next thing we will find will be the angle increment, so that we may determine the face angles of the gears and we will find on the chart that the tangent of the angle increment

$$\text{or } v = \frac{\sin x}{\dfrac{n}{2}} = \frac{0.39741}{6} = 0.06623 = \tan\ 3°\ 47'.$$

The face angle of the larger gear $= y + v = 36°\ 35' +$

$3^\circ\ 47' = 40^\circ\ 22'$ and the face angle of the smaller gear $= 23^\circ\ 25' + 3^\circ\ 47' = 27^\circ\ 12'$.

Now for the outside diameters: For the larger gear the outside diameter, or $D = D_1 \times (D_2 \times \cos y) = 2.25 + (0.25 \times 0.80299) = 2.451$ inches.

For the smaller gear, the outside diameter, or $d = d_1 + (D_2 \times \cos x) = 1.5 + (0.25 \times 0.91764) = 1.729$ inch.

The number of teeth for which to select cutter for the larger gear $= \dfrac{18}{0.80299} = 22$. Therefore use No. 5 cutter.

The number of teeth to select cutter for the smaller gear $= \dfrac{12}{0.91764} = 13$; use No. 8 cutter.

Example 2: Tangent of center angle of smaller gear (see Fig. 2), or $\tan x = \dfrac{n}{N} = \dfrac{12}{18} = \dfrac{2}{3} = 0.66667 = \tan 33^\circ\ 41'$ —

Center angle of larger gear $= a - x = 90^\circ - 33^\circ\ 41' = 56^\circ\ 19'$

Tangent of angle increment, or $\tan v = \dfrac{\sin x}{\dfrac{n}{2}} = \dfrac{0.55460}{6} = 0.09243 = \tan.\ 5^\circ\ 17'$.

Face angle of larger gear $= y + v = 56^\circ\ 19' + 5^\circ\ 17' = 61^\circ\ 36'$.

Face angle of smaller gear $= x + v = 33^\circ\ 41' + 5^\circ\ 17' = 38^\circ\ 58'$.

Outside diameter of larger gear, or $D = D_1 + (D_2 \times \cos y) = 2.25 + (0.25 \times 0.5546) = 2.389$ inches.

Outside diameter of smaller gear, or $d = d_1 + (D_2 \times \cos x) = 1.5 + (0.25 \times 0.83212) = 1.708$ inch.

Number of teeth for which to select cutter for the larger gear $= \dfrac{N}{\cos y} = \dfrac{18}{0.5546} = 32$, hence use No. 4 cutter.

Number of teeth for which to select cutter for smaller gear $= \dfrac{n}{\cos x} = \dfrac{12}{0.83212} = 14$; use No. 7 cutter.

Example 3: Tangent of center angle of smaller gear (see Fig. 3), or

$$\tan x = \frac{r}{\dfrac{R}{\sin b} - r \times \operatorname{cotan} b} = \frac{0.75}{\dfrac{1.125}{0.866} - 0.75 \times 0.57735}$$

$$= \frac{0.75}{1.299 - 0.433} = \frac{0.75}{0.866} = 0.86605 = \tan 40^\circ\ 54'.$$

Center angle of larger gear $= a - x = 120^\circ - 40^\circ\ 54' = 79^\circ\ 6'$.

Tangent of angle increment, or

$$v = \frac{\sin x}{\dfrac{n}{2}} = \frac{0.65474}{6} = 0.10912 = \tan 6^\circ\ 14'.$$

Face angle of smaller gear $= x + v = 40^\circ\ 54' + 6^\circ\ 14' = 47^\circ\ 8'$.

Face angle of larger gear $= y + v = 79^\circ\ 6' + 6^\circ\ 14' = 85^\circ\ 20'$.

Outside diameter of larger gear or $D = D_1 + (D_2 \times \cos y) = 2.25 + (0.25 \times 0.18910) = 2.297$ inches.

Outside diameter of smaller gear or $d = d_1 + (D_2 \times \cos x) = 1.5 + (0.25 \times 0.75585) = 1.689$ inch.

Number of teeth for which to select cutter for larger gear $= \dfrac{N}{\cos y} = \dfrac{18}{0.18910} = 95$; hence use No. 2 cutter.

Number of teeth for which to select cutter for smaller gear $= \dfrac{n}{\cos x} = \dfrac{12}{0.75585} = 16$; use No. 7 cutter.

* * *

A six-inch Midvale case-hardened armor plate was recently tested at the Indian Head proving grounds with very satisfactory results, the penetration being less than two inches with a six-inch shell. The Midvale Company is said to have a secret process which is superior to the Krupp process controlled by the Carnegie and Bethlehem companies.

DRAFTING ROOM PRACTICE.

ROBERT GRIMSHAW.

I have read with interest the article by Mr. Ralph E. Flanders on drafting room practice, in your March issue, and would like to add something thereto.

In the first place, as to the drawing paper itself: When I spoiled paper in a ship works drawing office, we used "double elephant" size "egg shell" Whatman's paper mounted on linen, and expensive enough it was. The drawings were very often an infernal nuisance on account of their great size and the necessity for rolling them. The time spent on brush shading with India ink, sepia, and so on, and on fancy lettering would have paid for very many desirable changes in the drawing department. Now-a-days much of this sort of thing has been done away with but there is room for much improvement in just this particular. There are few establishments in which it would not be better, instead of a regular so-called drawing paper, to use either a good stout Manila paper on which the drawing is made in lead pencil and never inked in, or a semi-transparent stock upon which the original drawing can be made with India ink and afterward used without tracing for blueprinting. The use of Manila paper and lead pencils for original drawings is particularly to be recommended where, as in the automobile industry, every season is sure to bring some important changes, while orders for parts of each type are likely to come in for several years after the machines have left the works. From the original lead pencil drawings there may be made a good linen tracing which can be dated and from which blueprints may be taken, which, to all intents and purposes are the original drawings. Changes are easily made on such lead-pencil drawings, as the necessity for preserving the original lines no longer exists and new linen tracings may be made and marked with the second date. All the blue prints that are made therefrom bear this date and there can be no confusion; while the business of furnishing "repairs," which is usually most profitable, can go on without causing any uncertainty in the shop.

In marking the dimensions on drawings, especially for large work, the figures should be as far as possible either in feet all the way through, or in inches. If the two be used, the employment of the accent (′) for feet and the double accent (″) for inches should be avoided as a pestilence; not that one is likely to be in error as to whether the frame of an automobile is 13 feet or 13 inches long, but one can sometimes be in doubt as to whether a dimension is intended to be 11′ 8″ or 118″, especially where the whole of a piece is not indicated, but only the two ends are given.

A plain block or a simple italic letter is the best form to use. Architects have done much to spoil draftsmen in this particular. They often adopt a style of lettering so crazy as to be almost undecipherable. Underlining words has not, as draftsmen seem to think, the effect of making them more legible. "On the contrary, quite the reverse," as the Irishman said. Words are sometimes underlined in the text of books to give special emphasis to them or to attract the readers' attention, but this does not have the effect of rendering them more legible.

Marginal lines on drawings serve no useful purpose. They reduce the effective area of the sheet, for if one leaves a margin of one inch without indicating it by an actual line, one can draw clear up to the imaginary boundary. But if one fences off a margin by a real border, the lines of the drawing must be kept back from the fences at least half an inch. If the sheet of a detailed drawing is 9 x 12 inches and we leave a margin all round, we have already cut the available area to 65 per cent of the original size. If we still further reduce the area of the drawing itself by half an inch margin, we have only 77 per cent. of the former net area, or just one-half of the whole area of the sheet. A free one-half inch may be left for punch holes in which to insert patent binders which are so convenient for holding and keeping in place the various detail drawings of a set.

It is not sufficient just to "make" a drawing. After it is made, that is, after every line is drawn and all dimensions are entered thereon, the whole should be checked off with reference to every possible chance for error or improvement.

and this should preferably be undertaken by some one other than the draftsman who has done the work.

See that the parts are strong enough to do the work. See that they are of the proper materials and that all the dimensions are drawn to scale and check up with each other. Care should be taken that the proper number of pieces of each part for one machine, is called for on the drawing. The different parts should be so designed that the machining may be easily done with the facilities at the disposal of the establishment, and finish marks should be carefully checked to see that some parts are not marked to be finished which should be left rough, and *vice versa*. There should be, also, a correct list of the subsidiary but necessary articles to be drawn from the store house or ordered outside, as, for instance, oil cups, petcocks, and bolts.

Each part must be so designed that it may be readily removed for inspection or be easily accessible for cleaning and repairs. If the part is heavy, facilities should be provided for handling it, and some parts, such as cylinder heads, should have starting screws by which they can be given the preliminary lift from their seats. All moving parts should be furnished with lubricating devices so located that filling and cleaning may be easily attended to, and with oil passages so disposed that the lubricant will reach the surfaces for which it is intended without being frozen or dammed on the way. The different parts and dimensions of a machine wherever possible should conform to the standard in use in the country or shop to which they are to be sent. For instance, the standards of the Navy Department vary in some respects from those of the army, and this should be taken into consideration when doing work for either branch of the service.

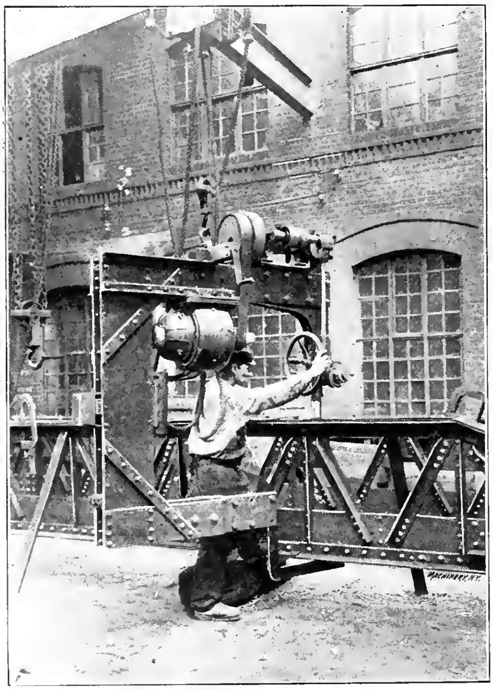


Fig. 1. A "Pendulating" Electric Drill.

A very important point is the question of clearance for moving parts. Are all the intended movements possible, or will some moving piece strike some other moving or immovable one? This has happened twice within my knowledge: once where the connecting rods of a locomotive were made too short so that a complete rotation was impossible, and again where the crank of a pump engine could never have made a complete rotation if the mistake had not been discovered before patterns were made for the beds and housings.

If the drawing is not carefully examined and checked off in all these particulars, there is danger of some mistake of omission or commission, in making or assembling, which will cost money or cause delay or, perhaps, even endanger life.

A PENDULATING ELECTRIC DRILL.

DR. ALFRED GRADENWITZ.

The drilling of structural and similar work, where the pieces have to be bolted or riveted together, is fraught with special difficulties. It has so far mostly been the practice to drill each of the pieces to be joined separately, and when they are put together the holes do not fit accurately on each other and some after work is always necessary. Under such conditions the rivets do not completely fill the holes, and an objectionable strain is produced. If on the other hand the various parts are placed one above the other and drilled together, another drawback is experienced, since the lower parts are thrown aside by the boring pressure and shavings get into the joints, so that to remove these the pieces have to be dismounted.

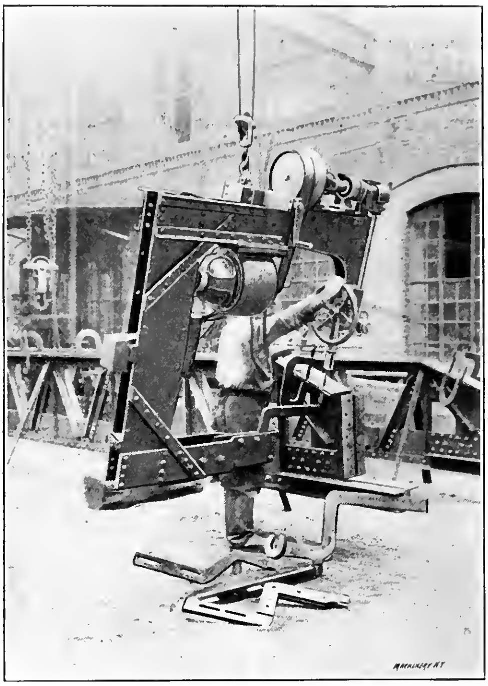


Fig. 2. Drill at Work on Angular Surface.

The pendulating electric drill just brought out by Karl Flohr, Berlin, is intended to obviate these drawbacks. It can be transported to the work, whatever the position of the latter, and the drilling is effected in a single operation. In fact, the arrangement of this drill in regard to the work is such that the pressure produced in drilling serves at the same time to compress the pieces and fit them together.

The arrangement and operation of this novel drill are illustrated in Figs. 1 and 2. It is supported by a traveling hoist by means of which it can be placed in a convenient position relative to the work.

The channel-shaped steel frame of the machine carries the drill spindle at one end, which is provided with power and hand feed, quick return, etc. An inverted closed motor bolted to the top of the frame drives the spindle through cone pulleys and belt transmission, and a pair of bevel gears. The lower part of the frame is so designed as to allow different braces being fitted to steady the frame, according to the shape to be drilled. Oblique as well as vertical holes can be drilled by changing the suspension point of the machine to one side or the other, as in Fig. 2, which causes the machine to hang in an oblique position. The machine can also be suspended so that horizontal holes may be drilled.

* * *

TABLE FOR COMPUTING HOLLOW AND SOLID SHAFTING

The table which is shown on page 21, contributed by R. R. Hillman, Buffalo, N. Y., will furnish a convenient means for comparing the relative strength and weights of solid and hollow shafting. It shows clearly the advantage of removing the core of the shaft, as is the common practice in marine engine work where lightness is necessary.

COMPARATIVE TORSIONAL STRENGTH AND WEIGHT OF HOLLOW AND SOLID SHAFTING, OF THE SAME MATERIAL.

UPPER FIGURES GIVE COMPARATIVE STRENGTH — LOWER FIGURES GIVE COMPARATIVE WEIGHT

EXAMPLE:—A 25" HOLLOW SHAFT WITH A 10" AXIAL HOLE WILL WEIGH 16.00% LESS THAN A 25" SOLID SHAFT, BUT ITS TORSIONAL STRENGTH WILL BE ONLY 2.56% LESS.

$$\frac{H}{S} = \frac{D^4 - d^4}{D^4}$$

D — D — d

DIAMETER OF AXIAL HOLE (columns) — DIAMETER OF SHAFT (rows)

D	4"	5	6	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19	20	21	22	23	24	25"	26	27	28
6	19.76 44.44	48.23 69.44																							
7	10.67 32.66	26.04 51.02	53.98 73.49																						
8	6.25 25.00	15.26 39.07	31.65 56.25	58.62 76.54																					
9	3.91 19.75	9.53 30.87	19.76 44.44	36.60 60.49	62.43 79.00																				
10	2.56 16.00	6.25 25.00	12.96 36.00	24.01 49.00	40.96 64.00	65.61 81.00																			
11	1.75 13.22	4.28 20.66	8.86 29.74	16.40 40.48	27.98 52.89	44.82 66.92	68.30 82.63																		
12	1.24 11.11	3.01 17.36	6.25 25.00	11.58 34.01	19.76 44.44	31.65 56.25	48.23 69.44	70.61 84.03																	
13"	0.87 9.46	2.19 14.80	4.54 21.30	8.41 29.00	14.35 37.87	23.00 47.90	35.02 59.17	51.27 71.61	72.61 85.22																
14	0.67 8.16	1.63 12.76	3.38 18.36	6.25 25.00	10.67 32.66	17.08 41.33	26.04 51.02	38.12 61.73	53.98 73.49	74.35 86.23															
15"	0.51 7.11	1.24 11.11	2.56 16.00	4.75 21.77	8.09 28.45	12.96 36.00	19.76 44.44	28.93 53.79	40.96 64.00	56.42 75.11	75.89 87.10														
16"	0.40 6.25	0.96 9.77	1.98 14.06	3.68 19.14	6.25 25.00	10.02 31.64	15.26 39.07	22.34 47.28	31.65 56.25	43.58 66.02	58.62 76.56	77.25 87.90													
17"	0.31 5.54	0.71 8.65	1.56 12.45	2.89 16.95	4.91 22.15	7.86 28.03	11.99 34.61	17.53 41.89	24.83 49.83	34.20 58.49	46.00 67.83	60.62 77.87	78.47 88.59												
18"	0.25 4.94	0.70 7.72	1.24 11.11	2.29 15.12	3.91 19.75	6.25 25.00	9.53 30.87	13.87 37.36	19.76 44.44	27.20 52.16	36.60 60.49	48.23 69.44	62.43 79.00	79.57 89.31											
19"	0.20 4.43	0.50 6.93	1.00 9.97	1.85 13.57	3.15 17.73	5.04 22.44	7.68 27.70	11.24 33.53	15.92 39.90	21.92 46.82	29.48 54.29	38.85 62.33	50.29 70.91	64.09 80.04	80.56 89.75										
20	0.16 4.00	0.40 6.27	0.81 8.10	1.51 12.25	2.56 16.00	4.11 20.25	6.25 25.00	9.16 30.26	12.96 36.00	17.86 42.25	24.01 49.00	31.65 56.25	40.96 64.00	52.21 72.23	65.61 81.00	81.46 90.24									
21"	0.14 3.62	0.33 5.67	0.67 8.16	1.24 11.11	2.11 14.51	3.38 18.37	5.15 22.67	7.54 27.44	10.67 32.66	14.69 38.32	19.76 44.44	26.04 51.02	33.70 58.04	42.95 65.51	53.98 73.49	67.01 81.85	82.28 90.70								
22	0.11 3.30	0.27 5.17	0.55 7.43	1.03 10.12	1.75 13.22	2.81 16.73	4.27 20.66	6.25 25.00	8.86 29.76	12.13 34.92	16.40 40.48	21.62 46.48	27.98 52.89	35.66 59.69	44.82 66.94	55.64 74.58	68.31 82.64	83.03 91.11							
23	0.10 3.02	0.23 4.73	0.47 6.50	0.86 9.26	1.47 12.10	2.35 15.31	3.58 18.90	5.24 22.88	7.41 27.22	10.21 31.94	13.73 37.05	18.10 42.53	23.42 48.39	29.85 54.61	37.52 61.24	46.57 68.23	57.18 75.61	69.50 83.36	83.72 91.49						
24"	0.09 2.77	0.19 4.34	0.40 6.25	0.73 8.50	1.24 11.11	1.98 14.06	3.02 17.36	4.12 21.01	6.25 25.00	8.61 29.34	11.58 34.02	15.26 39.06	19.76 44.44	25.18 50.16	31.65 56.25	39.23 62.67	48.23 69.44	58.62 76.56	70.61 84.02	84.35 91.84					
25"	0.07 2.56	0.16 4.00	0.34 5.76	0.62 7.84	1.05 10.24	1.68 12.96	2.56 16.00	3.78 19.36	5.29 23.04	7.32 27.04	9.84 31.36	12.96 36.00	16.78 40.95	21.39 46.23	26.88 51.92	33.37 57.84	40.96 64.00	49.79 70.56	59.97 77.44	71.64 84.48	84.94 92.16				
26"	0.06 2.36	0.14 3.70	0.29 5.32	0.59 7.24	0.90 9.47	1.45 11.98	2.19 14.79	3.21 17.90	4.54 21.30	6.25 25.00	8.41 28.99	11.08 33.28	14.35 37.87	18.28 42.74	23.98 47.93	28.52 53.40	35.02 59.17	42.56 65.24	51.27 71.60	61.24 78.26	72.61 85.21	85.49 92.45			
27"	0.06 2.19	0.12 3.43	0.25 4.93	0.48 6.72	0.78 8.78	1.24 11.11	1.89 13.72	2.74 16.60	3.91 19.75	5.57 23.18	7.23 26.88	9.53 30.87	12.34 35.11	15.72 39.63	19.76 44.44	24.53 49.51	30.11 54.86	36.60 60.49	44.08 66.39	52.66 72.56	62.13 79.00	73.51 85.73	85.98 92.72		
28"	0.05 2.04	0.11 3.19	0.22 4.59	0.40 6.25	0.67 8.16	1.07 10.33	1.63 12.76	2.39 15.44	3.38 18.36	4.65 21.55	6.25 25.00	8.24 28.70	10.67 32.66	13.59 36.85	17.08 41.33	21.21 46.04	26.04 51.02	31.65 56.25	38.12 61.73	45.53 67.47	53.98 73.49	63.56 79.72	74.35 86.23	86.47 92.98	
29"	0.04 1.90	0.09 2.97	0.19 4.28	0.33 5.82	0.58 7.61	0.93 9.63	1.42 11.89	2.07 14.39	2.94 17.12	4.04 20.09	5.44 23.30	7.16 26.75	9.27 30.43	11.81 34.35	14.85 38.52	18.43 42.92	22.63 47.56	27.50 52.43	33.13 57.55	39.57 62.90	46.91 68.49	55.23 74.31	64.62 80.37	75.14 86.68	86.91 93.21
30"	0.04 1.77	0.08 2.77	0.16 4.00	0.30 5.44	0.51 7.11	0.81 9.00	1.24 11.11	1.81 13.44	2.56 16.00	3.53 18.77	4.75 21.77	6.25 25.00	8.09 28.45	10.32 32.10	12.96 36.00	16.09 40.11	19.76 44.44	24.01 49.00	28.93 53.79	34.55 58.77	40.96 64.00	48.23 69.44	56.42 75.11	65.61 81.00	75.89 87.10
31"	0.03 1.66	0.07 2.60	0.15 3.74	0.26 5.09	0.45 6.66	0.72 8.43	1.09 10.40	1.59 12.59	2.25 14.99	3.10 17.58	4.16 20.39	5.49 23.41	7.10 26.63	9.05 30.06	11.37 33.71	14.12 37.56	17.33 41.62	21.06 45.89	25.37 50.36	30.31 55.05	35.93 59.93	42.30 65.03	49.49 70.34	57.57 75.86	66.56 81.58
32"	0.03 1.56	0.06 2.44	0.13 3.51	0.23 4.78	0.40 6.25	0.63 7.91	0.96 9.77	1.40 11.82	1.98 14.06	2.73 16.50	3.68 19.14	4.83 21.97	6.25 25.00	7.97 28.21	10.02 31.64	12.43 35.25	15.26 39.06	18.55 43.94	22.35 47.28	26.69 51.66	31.65 56.25	37.26 61.03	43.59 66.02	50.69 71.19	58.62 76.56
33"	0.03 1.46	0.06 2.29	0.11 3.30	0.21 4.49	0.35 5.87	0.56 7.43	0.85 9.18	1.24 11.11	1.75 13.22	2.41 15.52	3.24 17.99	4.27 20.66	5.53 23.50	7.05 26.53	8.86 29.76	10.99 33.14	13.50 36.72	16.40 40.48	19.76 44.44	23.60 48.57	27.98 52.89	32.94 57.39	38.51 62.07	44.82 66.94	51.83 71.98
34"	0.02 1.38	0.05 2.16	0.10 3.11	0.18 4.23	0.31 5.54	0.50 7.00	0.75 8.65	1.10 10.47	1.56 12.45	2.14 14.62	2.88 16.95	3.79 19.46	4.91 22.15	6.25 25.00	7.86 28.03	9.76 31.22	11.98 34.61	14.56 38.15	17.53 41.89	20.95 45.76	24.83 49.83	29.21 54.06	34.20 58.49	39.77 63.06	46.00 67.83
35"	0.02 1.30	0.05 2.04	0.09 2.93	0.16 2.93	0.28 5.22	0.44 6.61	0.67 8.16	0.98 9.88	1.39 11.75	1.91 13.79	2.56 16.00	3.38 18.36	4.37 20.89	5.57 23.58	7.00 26.44	8.69 29.46	10.67 32.66	12.96 36.00	15.62 39.51	18.65 43.18	22.11 47.02	26.04 51.02	30.46 55.18	35.42 59.51	40.96 64.00

Machinery, N.Y.

RELATIVE SPACE OCCUPIED BY TURBINES AND ENGINES.

Diagrams have occasionally been published showing the relative floor area and head room required for steam turbines and reciprocating engines, but comparisons have usually been made between units of large power, the engines being of the slow-speed type, and consequently large and massive for the work they have to do.

We show on this and the opposite page, several diagrams of this nature, but they are a little fairer to the steam engine than usual, because the engines taken for comparison with the turbines are of high or medium speed. Inasmuch as turbines are high-speed machines, it is only just to contrast them with engines designed to run at moderately high speeds. Even with this advantage, however, it will be evident from the diagrams that a power unit, consisting of an engine and generator, occupies very much more space than a turbine and generator. A considerable part of this additional space is required for the generator and flywheel, the former of which is much more bulky in the case of the engine than with the turbine outfit, and the latter, of course, is not required at all with the turbine.

In these general views we have shown only the engines, or turbines, and generators, and have not included the condenser and auxiliary apparatus. Inasmuch as the turbine should operate at a higher vacuum than the steam engine, much larger condensers and larger auxiliary apparatus are required, so that the relative space occupied in a power plant by an engine outfit and a turbine outfit complete, does not show so great a discrepancy as would be inferred from the drawings here shown. We intend in a future number to publish several diagrams indicating the space required for turbines and their condensing outfits, by the aid of which a fairer estimate of the floor space necessary for a complete generating outfit can be made.

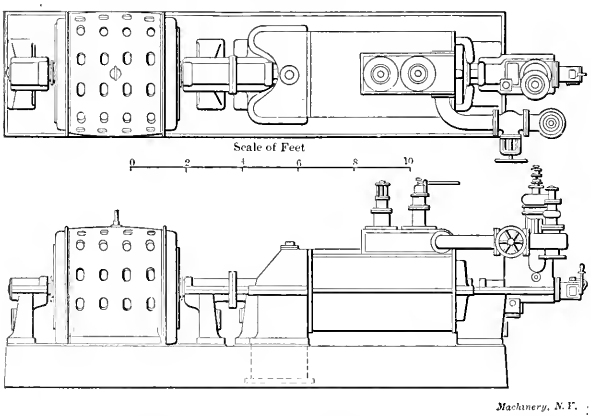


Fig. 2. Plan and Elevation of 500 K.W. Westinghouse-Parsons Steam Turbine.

All of the drawings shown in this connection are to the same scale and probably the case made out is as good a one for the steam engine as is possible.

In Fig. 1 are a plan and elevation of a McEwen tandem compound high-speed engine, having cylinders 21 and 36 x 24. This type of engine is probably the most compact of any of the horizontal engines. The machine from which the diagram of Fig. 1 was taken was designed to be direct-connected to a 400-kilowatt alternating-current generator, and to run non-condensing. If run condensing, however, it would be ample to drive a 500-kilowatt generator, and the Ridgway Dynamo & Engine Co., who are the builders, inform us that if connected to a 500-kilowatt Thompson-Ryan direct-current generator, which they build, the space occupied by the latter would be no greater than the space required for the 400-kilowatt alternating-current machine. The plan view in Fig. 1 shows the top of the foundation, which is about six inches larger all around than the base of the engine bed. The foundation is also shown for the generator and outboard bearing.

In Fig. 2 are a plan and elevation of a Westinghouse-Parsons steam turbine, direct-connected to a 500-kilowatt generator.

In Fig. 5, on the opposite page, is another horizontal engine, which may fairly be compared with the horizontal type of turbine. This engine is of Rice & Sargent design, built by the Providence Engineering Works, and has cylinders 18 and 36x32. It is direct-connected to a 500-kilowatt generator, and as the engine has a stroke of only 32 inches it is intended to run at a moderately high speed, for the Corliss type of engine. This machine, it will be noted, is a cross-compound engine, and consequently occupies relatively more space than the tandem engine of Fig. 1.

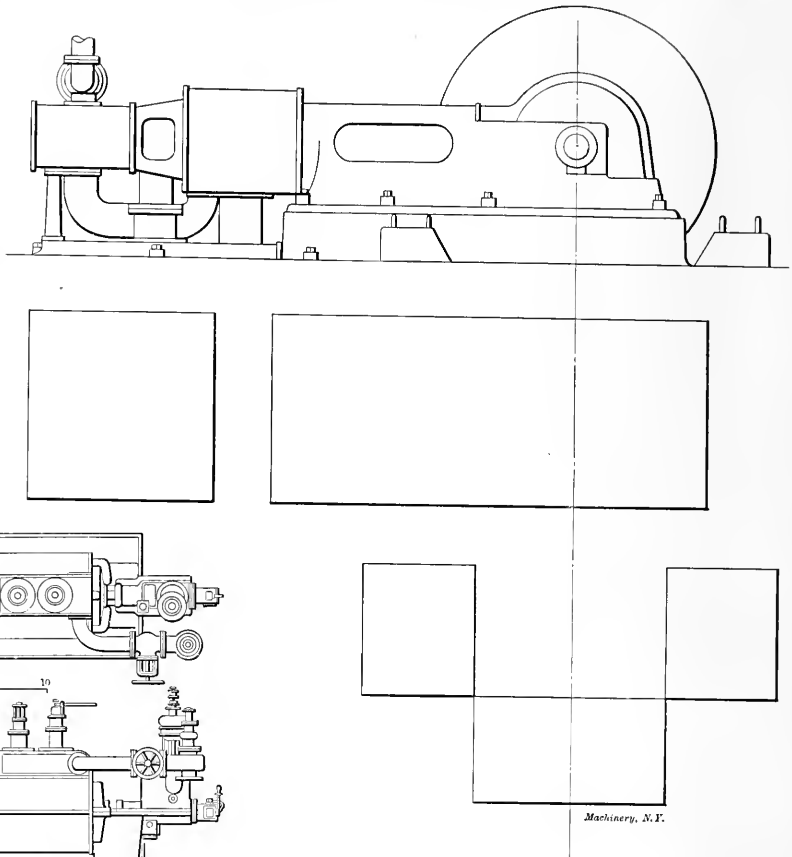


Fig. 1. Elevation of McEwen Tandem-compound High-speed Engine suitable for Connecting to 500 K. W. Generator, together with Foundation Plan.

In Fig. 3 is illustrated a cross-compound vertical engine, driving a 500-kilowatt generator, and for comparison with it is a vertical Curtis turbine of the same capacity, in Fig. 4. The diagram of Fig. 3 engine represents one of the medium-speed engines built by the Shepherd Engineering Co. This company also manufacture a vertical high-speed engine of the same power, which runs at 225 revolutions a minute. The area occupied by this latter machine, including its generator and outboard pedestal, which supports the outer end of the generator shaft, is about 9 feet by 22 feet. The area occupied by the medium-speed engine, exclusive of the extra width necessary to accommodate the large flywheel and generator, measures about 8½ by 19 feet; but with the above width added, the total space would be a little greater than for the high-speed machine, which has a smaller flywheel and generator. The heights of the two engines are practically the same.

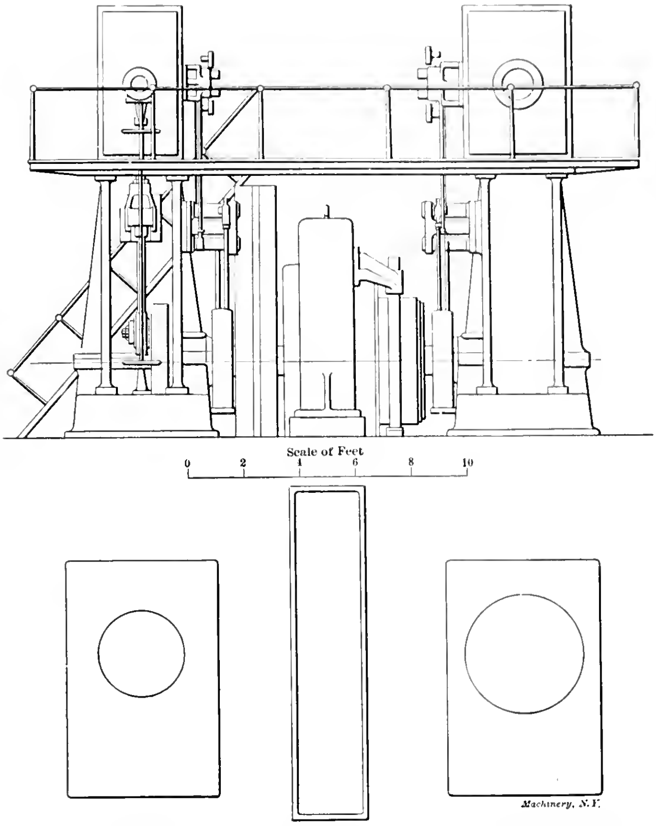


Fig. 3. Plan and Elevation of Medium Speed Compound Vertical Engine Direct-connected to 500 K.W. Generator.

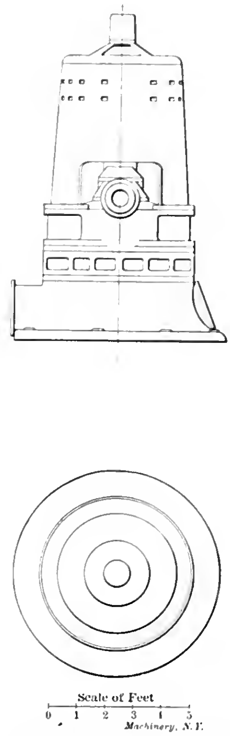


Fig. 4. Plan and Elevation of 500 K W. Center Turbine and Generator.

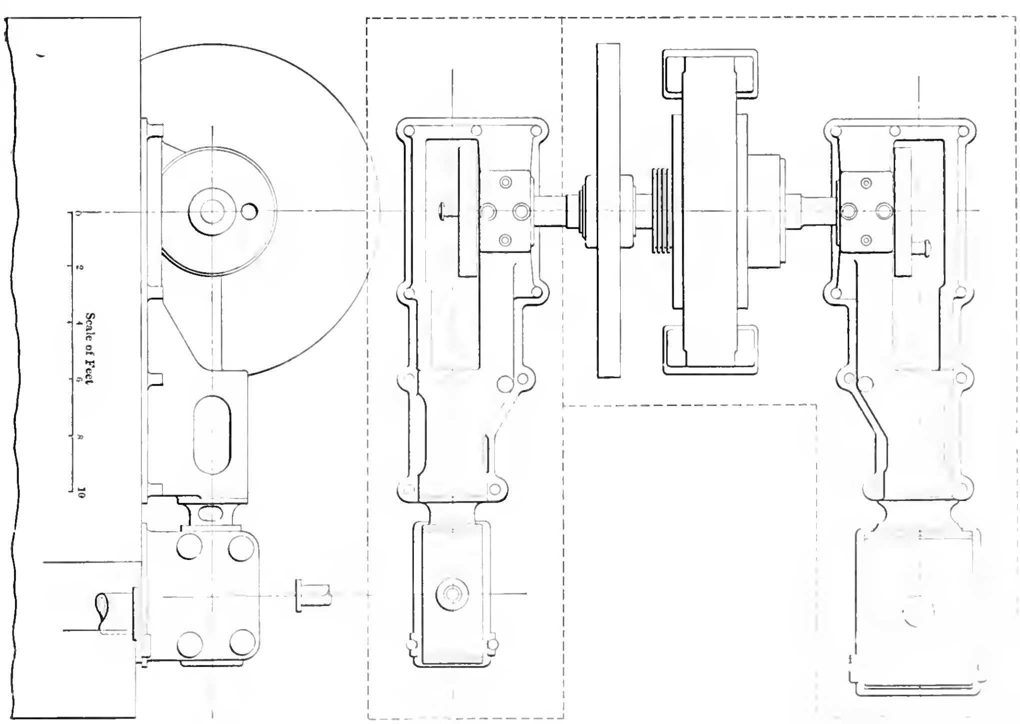


Fig. 5. Plan and Elevation of Medium Speed Corliss Engine Direct-connected to 500 K W. Generator

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

This number marks the beginning of the twelfth volume of MACHINERY. The index for the eleventh volume is now ready, and one will be sent to any subscriber asking for it. In writing state whether an index is desired for the Engineering or Shop Edition.

* * *

We have previously announced that the September number would be a "draftsmen's number," which accounts for the fact that the space in the current issue is mainly devoted to technical articles of value to draftsmen and machine designers. The data sheet supplied with the Engineering Edition is double the size ordinarily furnished and contains the most complete and accurate set of formulas upon loaded beams that has ever been prepared. Dr. Sanford A. Moss, the author of these, has had long training and experience in mathematical work connected with engineering and physical problems, and has calculated his formulas from "first principles," not depending upon equations given in textbooks or elsewhere. The proofreading of this data sheet has been done with extraordinary care and we believe the result to be a nearly perfect table—we do not dare say a perfect one.

* * *

THE GEARED DRIVE.

From the present trend in machine-tool design it is probable that the geared, variable-speed drive will be adopted by manufacturers of nearly all types of tools to a greater or less extent. It is not to be expected that this form of drive will supersede the belt and cone, but it will undoubtedly displace the older form on many machines designed for high-speed steels.

Whether this tendency is a fad remains to be seen. The inflexibility and large number of parts that are characteristic of an all-gear head invariably lead to occasional breakages. It is doubted by many whether, after all, the advantages to be derived from such a construction are sufficient to offset the flexibility and simplicity of the old-fashioned belt drive.

Several years ago, when the multiple-voltage direct-current system of electrical transmission was being introduced, some designers of machine tools predicted that it would be superseded by constant-speed motors combined with variable-speed gear drives for machine tools, because this arrangement would be simpler than the multiple voltage system and its complicated wiring, its equalizer, etc.

Since that time, however, variable speed motors operated by field control or other means, more simple than the multiple voltage system, have come into use, but along with these systems mechanical variable-speed arrangements have also been developed by machine tool builders as a part of the machines themselves, so that the purchaser of machine tools has a wide latitude in choosing the kind of drive that he prefers. We should like to hear from readers who have had experience with different systems of speed control—especially mechanical devices. The subject is worth more attention than it has received.

* * *

INDENTURED APPRENTICES.

The Deane division of the International Steam Pump company are to resume the indentured apprentice system that has been out of vogue among the mechanical and machine plants of the country for quite a number of years, but which has been revived among them the last two or three years to quite an extent. There is a decided lack of expert machinists such as it is believed are only or at least best produced under the indentured system, by which a young man under 21 is bound for four years, and 21 or over for three years to the company to learn the business thoroughly. By its terms the young men receive five cents an hour at first, increasing each six months, and at the end of the apprenticeship are paid a bonus of $100. They are then supposed to be and in most cases are able to earn the wages of a fully equipped machinist, which range from $2.25 a day upward, according to the work, the shop, and the skill of the machinist. Years ago the Deane company used to do the same thing, but has not for a number of years; and in now taking it up it is doing what many large shops have deemed it advisable to do.—*Springfield Mass., Republican.*

This press item correctly outlines the conditions that many manufacturers are finding themselves up against. It is inevitable that any system for training employees which is as superficial, incomplete and as loosely conducted as the modern plan of breaking in "hands" must eventually fall to the ground. It is very true that "all round" machinists are not required to anything like the extent, relative to the total number of men employed, that they were a few years ago, though there are few shops where good machinists are not appreciated, and needed, also, for more or less of the work that is done. But beyond all this, it must be recognized that men are wanted, whatever the kind of work, who are able to use good judgment, and who are reliable.

How are we getting these men? Under the present manufacturing conditions it is thought advisable to employ operatives, instead of machinists, who, by a few months' experience, learn to do one thing rapidly and to turn out a large quantity of work at a low cost of production. Employers do not want to bother with the instruction of apprentices in several lines of work, and boys, on their part, who can see the prospect of earning $2.00 a day by piecework, within a comparatively short space of time, by becoming proficient hands, do not want to spend the four years necessary to learn the trade, during which time they would have to work for small wages. The consequence is that we are not making reliable and efficient workmen. There is no short cut to this end any more than to any other object worth striving for. A bright boy may learn the main facts about an engine lathe in six days, but it will require six months to learn to use his calipers, or to have good judgment about his speeds and feeds.

It is hard for a boy to appreciate the value of long training on these different machine shop operations and it is the common experience of employers that apprentices will leave before completing their full course and hire out as competent hands, or even as journeymen, unless they are under bond to spend their full time under instruction. This is why the indentured system is to be desired. It is better for the boy and better for his employer. Along with it should go a disposition on the part of the employer to give the boy a square chance, even at some inconvenience. The apprentice works at low wages, and it is generally conceded that he is able to make good, even if shifted around considerably. If he is unable to make good it is pretty certain that he ought to do something else for a living.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH

The monthly bulletin of the Fidelity and Casualty Company reports a flywheel accident at Memphis, Tenn., which is thought to have been caused by a loosening of the pillow-block. All circumstances of the accident indicate that the pillow-block gave way and that the wheel was broken by being brought in contact with the side walls of the wheel-pit. The entire engine was wrecked, being reduced to a condition worthless except for junk.

The use of plaster of paris is frequently hampered by the fact that it sets very quickly after being mixed. It is often desirable to use it in places where large quantities should be mixed at one time, but its quick-setting quality makes very rapid work necessary. A correspondent of the *Pattern Maker* says that if one part lime is mixed with five parts plaster of paris the mixture will set slowly but will harden just as well eventually as the pure plaster of paris.

The Chinese Government, according to German papers, has granted its first patent. It is for an electric lamp, the inventor of which is an inhabitant of Nankin, the old capital of the Chinese Empire, who calls his lamp the "bright moonlight," and asserts that it is far superior to foreign glow lights that hitherto have been sold at Shanghai and other Chinese cities. The fact that China has entered upon the granting of letters patent is undoubtedly of more importance than the invention.—*Consular Report.*

An illustration of the error of some common impressions is shown in what has been found to be the best and safest construction for windmill towers. The not unnatural idea that a windmill tower screened by large buildings or trees, or behind a hill would be less likely to be overturned by windstorms than if in the open, was found many years ago to be erroneous. The safest place for a windmill tower is on a spot where the wind can strike it fairly from every direction. In such a location the veering, shifting currents are less pronounced than behind buildings or hills, and there is also less of a lifting force to the wind in the open than behind obstructions.

Nickel vanadium steel has been made containing 0.141 per cent carbon, 0.512 per cent manganese, 9.36 per cent nickel, and 0.29 per cent vanadium, which showed a tensile strength of 101.2 tons per square inch. The best previous record for nickel steel was 88.8 tons. The tensile strength of mild steel contining 0.25 per cent carbon and 0.40 per cent manganese was raised from 30 tons to 47 tons per square inch by the addition of 0.25 per cent vanadium. As a result of the tests, Prof. Arnold said that it demonstrated beyond a doubt that the addition of a few tenths per cent of vanadium raises the elastic limit of mild construction steel at least 50 per cent without seriously impairing its ductility.

According to a newspaper item, the lifting magnets, which we have described in the columns of MACHINERY, are useful for other purposes than that of lifting masses of iron and steel. It appears that a gambling business is being done on a steamer anchored in Lake Michigan, opposite Chicago, racing news being conveyed between it and the shore by means of wireless telegraphy. The wireless telegraph works all right except when the lifting magnets used by the Illinois Steel Company at the mouth of the Calumet River are in operation, and then the wireless telegraph goes out of business. The work of loading steel plates begins at two o'clock and continues until six. During this period it is alleged that it is impossible to transmit wireless messages.

The general report to the London Board of Trade on railway accidents in 1904, issued on July 17, states that the danger of railway traveling has been reduced to such a point that in 1904 the chances against a passenger being killed in a train accident in the course of a given journey were more than 200,000,000 to 1. The risks incurred by railway servants, especially those concerned with the movement of traffic, are of course much greater. In their case there is an element of danger which cannot be eliminated, though its effect may be minimized by the adoption of suitable appliances and safeguards. The increasing use of such appliances is having an appreciable effect, but it is claimed that the carelessness engendered by familiarity with dangerous conditions appears to be responsible for so many accidents that it is unreasonable to expect any marked reduction in the total number of accidents to railroad servants.

The Mining Reporter says that in the quest for gold every known invention and discovery of science is made to contribute its share toward reducing the difficulties of the search by increasing the facilities for travel. It is still within the memory of a few pioneers when ox teams were the only means of transportation for crossing the plains to the gold mines. From ox teams in the '60s to automobiles traversing the Nevada deserts in the twentieth century is a far cry, but it is only indicative of the rapid progress of modern times. Twelve automobiles are now in operation between Las Vegas, Bullfrog and Goldfield, and this new method of transportation in the mining industry is considered a notable innovation. The new line, which is operated in two divisions, is taxed to its utmost capacity. The first division is from Las Vegas to Bullfrog, a distance of 124 miles. This run is made in 14 hours and the fare is $40 per passenger. On the second division, from Bullfrog to Goldfield, a distance of 70 miles, the company makes a charge of $25 per passenger.

When a chunk of cold cast iron is thrown into a ladle of liquid iron, it immediately sinks because it is heavier than the molten iron. But, says the *Ironmonger*, in a moment or two the iron, still solid, but white hot, will rise and float upon the surface, which is proof that it has expanded more than the molten iron and is consequently lighter. The piece will become rapidly smaller and sink below the surface as the last portion melts, which proves that at melting it is not as light as when it floated on the surface. The converse of this action is that molten iron shrinks as it cools until crystallization takes place, when it slightly expands, the amount of final shrinking depending upon the difference between the total shrinkage and the expansion caused by crystallization. In an inch test bar cooled in the mold the greatest expansion is reached in about fifteen minutes after the mold is filled, but a larger bar, say four inches square, does not stop expanding for one and a half hours, and it is for this reason that the final shrinkage of a large casting is less than of a smaller one.

At the recent meeting of the N. E. Cotton Manufacturers' Association Mr. George I. Rockwood thus expressed himself regarding boiler draft production:

"By means of a fan a smaller installation of boilers will do the work of supplying sudden demands of dye-house or bleachery for gusts of steam for an hour or two, than would otherwise be required. This is much the more economical scheme as compared with the large reservoir of hot water idea, embodied in a much larger boiler plant than the fan would make necessary and working the greater part of the day very lazily under a light chimney draft, simply to be there when the heavy demands for steam come. It is not, apparently, generally realized that a stoker grate is more durable under a heavy fire than under a light one; and sudden changes from heavy fires to light ones cause the grate to burn out very fast. Again, a mechanical draft system, costing $5,000 installed, will do the work of sixteen 220-horse-power boilers with twelve, the sixteen having only a 175-foot stack. Each boiler with its full equipment and building costs about $8,000. The difference between sixteen and twelve is four boilers saved, or $32,000. Thus there can be no question as to the desirability of providing both chimney and fan in this class of boiler plants; and the same thing has been found true in large electric power plants."

Aluminum paper is now manufactured in Germany and recommended as a substitute for tin foil, says Consul-General Guenther, of Frankfort, Germany. It is not the so-called leaf-aluminum, but real paper coated with powdered aluminum, and is said to possess very favorable qualities for preserving articles of food, for which it is used as a covering. Chemical analysis has proven that aluminum paper contains but few foreign substances; occasionally it may contain up to 2 per cent. of iron, but never any arsenic or other poisonous metals. Hence it appears that the powdered aluminum used for the manufacture of aluminum paper is relatively pure. The paper used is a sort of artificial parchment, obtained through the action of sulphuric acid upon ordinary paper. The sheets are spread out and covered upon one side with a thin coating of a solution of resin in alcohol or ether. Evaporation is precipitated through a current of air and the paper is then warmed until the resin has again become soft. Then powdered aluminum is sprinkled upon it and the paper subjected to strong pressure to fasten the powder thereon. The metallic covering so obtained is neither affected by the air nor by fatty substances. Aluminum paper is much cheaper than tin foil and will, so it is thought here, become a strong competitor thereof.

The use of wind as a motive power is declining in European countries, according to the *Mechanical Engineer*. The mills for grinding corn operated by wind are not in a prosperous condition and few of them grind wheat into flour, being mostly confined to crushing grain for cattle. Many of the mills which formerly depended entirely on wind as a motive power have installed auxiliary power in the shape of oil or steam engines. The present-day farmer is too busy to wait, as previously, until the wind is favorable for grinding, but requires his corn ground at once. As between the mill dependent upon the wind and the one having an engine, the latter will receive the most of the business in that vicinity. In short, modern conditions demand that motive forces shall be amenable to the requirements of the users, and that they shall not be at the mercy of the weather. That wind power may be utilized in great quantities is possible, but it will have to be done under entirely different conditions than are now feasible with the present apparatus. The difficulty of using the power of the winds is in kind similar to that of getting power from the ocean's tides and waves; the cost of the apparatus is so great as compared to the power obtained that the interest on the capitalization becomes ruinous. It would appear that, if wind and wave power be used largely in the future, our descendants will have to devise ways for obtaining such power by other than mere physical means.

Mr. Alex. Del Mar contributes to the July *Engineering Magazine* an enthusiastic article on the gold dredges and the effect they are to have in the social and economical developments of the future. He says: "The world is not only to be saturated with gold; it is going to be nauseated. These gold ships will sail all over the vast areas of low grade auriferous soil throughout the world, which are at present unworked, and discharge their precious cargoes into the mints. The gold ship is a dredge which floats in a pond of its own making, a pond which accompanies it wherever it chooses to go, and which enables it to move over the land in any direction; thus imbued with volition it advances to the point of attack, scoopes up the gravel, subjects it on its decks to the action of riffles, undercurrents and amalgamation—indeed to any desired process, whether mechanical or chemical, and then having exhausted it of its gold, casts gravel behind and keeps on advancing until the field before it is sifted and treated from surface to bedrock.

"These dredges cost from \$35,000 to \$50,000 each, according to size. The present rate of outturn is about one machine per week; in the course of a few years it will be one per diem; in ten years it will probably be ten machines per diem. When this takes place, and perhaps before it, the world's production of gold, even should the quartz mines yield no more than at present, will be two million dollars a day.

"When, during the sixteenth century, the mines of America threw upon the world a vast and unlooked for supply of the precious metals, the result was to impart a sudden and tremendous stimulus to production, invention and discovery. The Halcyon ages dawned; and Europe rose at a bound from penury, ignorance and retrogression, to comfort, enlightenment and progress. That such may be the bright future before us of to-day, nothing seems wanting but to let the Gold Ships pursue their eventful voyages in peace."

What is undoubtedly one of the most remarkable mineral deposits in the United States, if not the most remarkable, is the sulphur bed in Calcasieu Parish, Louisiana. For many years it has been known that a large tract of land in this locality was underlaid by a sulphur bed of unknown depth, 500 or 600 feet below the surface. Boring tools have penetrated the sulphur deposit to a depth of 200 feet and how much deeper it is, is not generally known, although it may be known to those who are at present engaged in working the deposits. Because of the character of the soil (quicksand) which overlays the sulphur deposit, many schemes were tried unsuccessfully for working it, until a Western engineer conceived the idea of sinking a bore hole into the sulphur and softening it with steam pressure so that it could be forced out by powerful pumps. This scheme worked successfully, and the plant now in operation has a capacity of something over 200 tons daily. The sulphur is allowed to flow from each discharge pipe into an open vat, constructed on the ground and there it is allowed to harden in a layer about 18 inches thick. After hardening the sulphur is broken up and shipped in bulk in car-load lots. It is believed that the business is controlled by the Standard Oil interests operating under the name of the Union Sulphur Company. The sulphur obtained is so pure that it is used without refining for a great variety of commercial purposes. When it is considered that the sulphur deposit in this place is practically inexhaustible and that it can be mined at a trifling expense, it is quite probable that sulphur will enter very largely into the arts where heretofore its use has been limited on account of cost, although as yet the price is fixed at \$15 to \$20 per ton. It is said that the company will soon be in a position to produce something like a million dollars worth of sulphur a year.

The actual volumetric capacity of a given fan, operating under practical conditions, is naturally to be sought as a means of measuring it relatively to any other fan. But manifestly such capacity is somewhat difficult of pre-determination. In the case of a steam engine, its normal rating—that by which one engine may be measured relatively to another—is based upon the diameter, and stroke of the cylinder, the number of revolutions and the mean effective pressure. But the power thus calculated by no means represents the amount which may be delivered to a given machine, for the sole purpose of operating which the engine is employed. This latter amount will be less than that calculated, to the extent that power is absorbed in the internal friction of the engine and by the intermediate mechanism of transmission. So in the case of a fan wheel, its theoretical volumetric capacity will depend upon its dimensions and the speed at which it is operated. But in practice the actual amount of air delivered will also be largely dependent upon the fact of the wheel being encased, the character and dimensions of the case, and the size and resistance of the passages through which the air is conducted. The equivalent of such resistance is in boiler practice usually represented by the grates, the fuel, tubes, etc., and may evidently be so great at times as to very seriously reduce the theoretical air discharge of the fan.

Evidently, it is improper to compare fans when operating under such conditions that these resistances cannot be definitely determined. The simplest and most natural condition is that in which the fan is operated without other resistance than that of the case; that is, with open inlet and outlet. But for proper comparison of different fans, the areas through which the air is discharged should bear some constant relation to the dimensions of the wheels themselves.

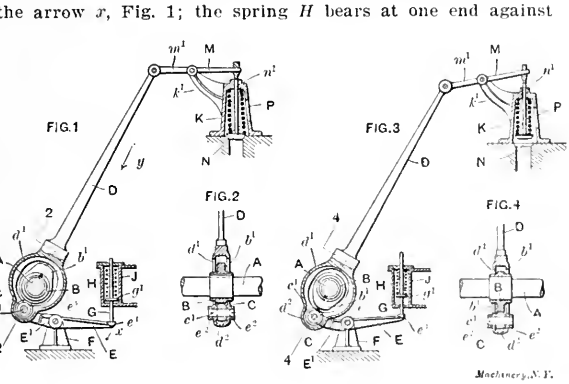
It has been determined experimentally that a peripheral dis-

charge fan, if enclosed in a case, has the ability, if driven to a certain speed, to maintain the pressure corresponding to its tip velocity over an effective area which is usually denominated the "square inches of blast." This area is the limit of its capacity to maintain the given pressure. If it be increased the pressure will be reduced, but if decreased the pressure will remain the same. As fan housings are usually constructed, this area is considerably less than that of either the regular inlet or outlet. It, therefore, becomes necessary, in comparing fans upon this basis, to provide either the inlet or the outlet with a special temporary orifice of the requisite area and proper shape, and to make proper correction for the contracted vein. The fan is thus, in a sense, placed in a condition of restriction of discharge, which it approaches in practice only in so far as the resistance of pipes, passages and material through which the air must pass has the effect of reducing the free inlet or outlet of the fan.—*Extract from treatise on Mechanical Draft, published by B. F. Sturtevant Co.*

VALVE OPERATING MECHANISM FOR STEAM ENGINES.

Mechanical Engineer, May 20, 1905.

The valve gear described below is the invention of Fried Krupp, Essen, Germany. Upon the driving shaft A of the engine is keyed a cam disk B, a portion of the periphery of the latter being concentric with the shaft A, while the remaining portion forms a cam projection b_1. Bearing upon the periphery of the cam disk B is a bowl C carried and revoluble upon a spindle c_1. This bowl lies on the side of the cam disk B opposite the length of the valve rod D, and the axes of the bowl C, the valve rod D and the main driving shaft A, are in one and the same plane with each other both when the valve is closed and when the latter is completely open. The yoke d_1 is of U-shape, and of such internal dimensions that the cam disk B can freely rotate in the yoke d_1, the lowermost portion of the latter being formed into a reservoir d_2 which surrounds the bowl C, leaving a space, however, which can be used to hold lubricating oil. The spindle c_1 of the bowl C projects on both sides beyond the walls of the yoke, and upon its projecting ends fit the eyes e_2 of a forked arm E_1 of a balance lever E E_1, the eyes being connected to the ends of the spindle by means of pins. The balance lever E E_1 oscillates on a spindle e_3 carried in a stationary standard F, and against the cup-formed end of the arm E bears a spring-pressed bolt G tending to rock the balance lever E E_1 in the direction of the arrow x, Fig. 1; the spring H bears at one end against



a collar g_1 on the bolt G, and at the other end against a stationary top of a casing J, which latter is mounted on the frame of the engine and acts as a guide for the bolt G.

The spring H is a comparatively weak spring and merely serves to balance or equalize the weight of the valve rod D and the bowl C, and also helps to keep the bowl C always in contact with the periphery of the cam disk.

The upper free end of the valve rod D is pivotally connected to the arm m_1 of a valve lever M which oscillates in a bracket bearing k_1 on the valve casing K and transmits the motion of the valve rod D to the spindle n_1 of the valve disk N. The valve disk N is held down on its seat by the spring P which is considerably stronger than the spring J.

Owing to the peculiar connection of the bowl C with the valve rod D effected by the yoke d_1, it will be seen that the arrangement of the valve operating mechanism is rendered very compact and at the same time the mechanism insures that the valve rod is subjected to tension only; moreover the torsional stresses on the shaft are reduced to a minimum. These are advantages which become specially prominent in the case of large engines with very wide bed-plates and long valve rods which bend easily.

OIL SEPARATOR.

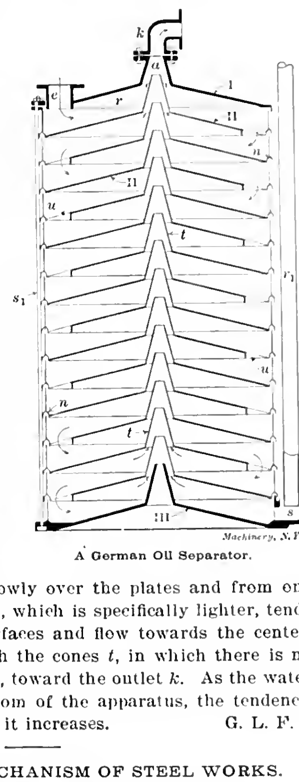
Der praktische Machinen-Konstrukteur, February 2, 1905.

The apparatus shown in section in the illustration serves the purpose of automatically removing the oil from the water of condensation in a very simple and efficient manner.

It carries a lid, I, shaped like an inverted funnel. It is fitted with an inlet e and an outlet a, and beneath there may be any desired number of plates, II having openings u in the top, and a cone rising from the center, while the bottom III is provided with a side bracket S from which the pipe r' rises.

Each plate has a groove n at the periphery which rests upon a ring on the one below, so that the whole nest can be tightly fastened together by three screws s, and leakage prevented. The apparatus is made entirely of cast iron and only three patterns are needed.

The water containing the oil flows in at the inlet e into the upper space r and thence with a diminished velocity down through the opening u to the next chamber, thence into the third, and so on. This continues until the apparatus is full. Any further influx of water is relieved by an escape through the pipe r'.



A German Oil Separator.

While the water flows slowly over the plates and from one chamber to the next, the oil, which is specifically lighter, tends to gather on the under surfaces and flow towards the center, and finally rises up through the cones t, in which there is no upward circulation of water, toward the outlet k. As the water flows down toward the bottom of the apparatus, the tendency of the oils to separate from it increases. G. L. F.

ADVANCE IN THE MECHANISM OF STEEL WORKS.

Iron and Machinery World, June 3, 1905.

One of the latest ideas, which is about to be carried out on a very large scale with regard to steel rail mills, is that the rolls shall be driven by motors, whose powers will be developed by gas engines driven by the gas from the blast furnaces, says a foreign exchange. The power thus obtained will be delivered as current to motors at the rolls, to which they will be connected by gear, and will supplant the present steam engines now in use for driving these rail mills. The improvement in plate mills for rolling steel plates is as great as that which has taken place in the steel rail mill. Thirty-five years ago a plate mill making 100 tons of plates per week was considered to be doing fair work. To-day a mill making a similar class of steel plates, but of much larger area, is turning out easily about eighteen times that quantity, and in America the enormous make of 450 tons has been rolled in twelve hours.

These large quantities are again due to improvements brought about by mechanical appliances, for handling large ingots or blooms weighing many tons with greater ease than was formerly the case when the weight of the ingots was only hundredweights handled by manual labor. Krupp was considered to have done marvelous work in showing an

ingot weighing about a couple of tons to the Exhibition in 1851, though it must be remembered that this was made from crucible steel. To-day ingots can be made of almost any weight, and their size is practically governed by the power of appliances used for moving them. At the St. Louis Exhibition a model was shown of a cylinder weighing 150 tons which had been cast in nickel steel for a 10,000-ton forging press. Ingots of 60 tons weight for armor plates are not infrequent.

In plate mills the improvements in rolling engines, the adoption of universal rolling trains, enormous hot slab shears, cranes of all descriptions for handling, charging, and drawing material from heating furnaces, cooling and straightening roller tables, cold shears capable of cutting plates up to 2½ inches thick, cooling-floors fitted with caster rollers by which these heavy plates are easily moved, have all contributed to the great outputs of steel rolling mills, and have enabled steel plates to be produced at prices not dreamed of in former years. While referring to the improvements in making steel plates and rails, one must not omit to mention the great strides made of late years by hydraulic forging. The forging press has been much improved upon. Hydraulic presses of 5,000 and even 10,000 tons are not uncommon, and for working large masses the hydraulic forging press seems to have almost replaced the steam hammer.

LARGE STEAM TURBINE INSTALLATIONS.

Electrical Review, July 22, 1905.

With the successful closing of recent negotiations for two 7,500-kilowatt Westinghouse turbine type generating units, the New York Edison Company has inaugurated an important epoch in the history of metropolitan electric lighting in this country by adopting generating units of such unprecedented size.

The importance of this step is enhanced by the fact that these turbine units will be installed in the finest and largest of American central stations, Waterside station No. 2, that ultimately will contain ten units of the same size. Waterside station No. 1 is equipped with Westinghouse vertical three-cylinder compound superheated reciprocating engines which, although installed only a few years ago as then representing the highest type of large engine construction, have so soon been outclassed through the rapid advance of the steam turbine system. No less than eleven of these large engine type units are now in service in this station, each rated at about 6,500-horsepower capacity and direct-connected to a 3,500-kilowatt generator. The next step in the acquisition of larger units resulted in the installation of 5,000-kilowatt turbine units of the Curtis type.

In the equipment of the new Waterside station with Westinghouse turbine units of still greater capacity, over twice that of the original engine-type units, there will here exist a striking example of the extremely rapid development in power-station construction that has taken place since 1900.

The compactness of the new generating unit is evidenced by the small space it requires in the new power-station arrangement. Its overall dimensions are approximately: length, fifty feet; width, seventeen feet; height, fifteen feet; floor space, 850 square feet per unit net, or 0.113 per square foot per kilowatt capacity. A condenser of the surface type will be located beneath the turbine in the foundations proper.

The new turbines will operate under 175 pounds steam pressure, approximately twenty-eight inches vacuum and 100 degrees superheat, the normal speed of the unit being 750 revolutions per minute. Under these conditions the economy of the complete unit will be in the neighborhood of sixteen pounds per kilowatt-hour at full-rated load. Each unit will have an overload capacity of at least fifty per cent or will be capable of developing full-rated load without the use of a condenser. A distinctive feature of this design is that the turbine gives its best economy around full-rated load, although a large overload capacity is at all times instantly available when required without material sacrifice of efficiency. At this maximum load each turbine will be developing over 15,000 horse-power at the shaft, which is by far the greatest amount of power ever developed in a single prime-mover in stationary service.

The direct-connected turbo-generators will be of standard Westinghouse construction, delivering 6,600-volt, three-phase current to the high-tension network at a frequency of twenty-five cycles per second. The generators will embody the new enclosed construction which constitutes an important advantage in the entire elimination of the hum peculiar to high-speed turbine generators. They will have an efficiency approximating 97.5 per cent at full-rated load. Each generator will be able to sustain for several hours an overload of fifty per cent within reasonable temperature rise.

It is of interest in connection with this important installation that almost simultaneously three Westinghouse turbine units of the same size have been adopted by two large Brooklyn power stations, one for railway and the other for lighting service, making a total of over 50,000 horse-power in turbine machinery of this size. Two units will go to the Brooklyn Heights Railway Company and the third to the Brooklyn Edison Company.

THE HATCHET PLANIMETER.

Arthur B. Allen, in the Engineer, July 15, 1905, p. 481.

It is a singular thing that the hatchet planimeter has not come into general use instead of the more elaborate and costly instruments commonly employed, for it is capable of a very high degree of accuracy, cannot get out of order, and is most simple to make. The present writer has, for example, made a first-rate instrument out of an old steel spindle, with the aid of such tools as are to be found in the abode of any engineer, bending the steel, as seen in Fig. 1, in a gas flame. There is no reason, therefore, why everyone should not be equipped with a planimeter of this type.

To make it, all that is required is a steel rod about 15 or 16 inches long, and perfectly tapered toward both ends—the steel spindles used in cotton mills are just right for the purpose, being 16 inches long, 5/16 inch diameter at the thickest part, and nicely tapered both ways to about ⅛ inch. Usually the planimeter is made with two short legs, of equal length, but the writer finds it a very great improvement to make the pointed end about 4 inches long, to facilitate manipulation in tracing round the diagram. Of course, tapered spindles are not essential; a plain steel rod will do quite well.

First roughly file up the thinner end to a long point, and then finish the latter to a fairly sharp, but not too sharp, point to serve as the stylus, taking care to keep the shape true and symmetrical. A hone is the best tool for nicely finishing the stylus. Next bend the pointed end through rather more than a right angle, allowing such a length that the height over all is 4½ inches when the point is upright. Then bend the other end somewhat less than a right angle, exactly parallel with and on the same side as the former, allowing a length of about 1½ inch. This end must now be filed and finished to a sharp hatchet edge, slightly curved, with the line of the edge passing through the point first made. True alignment is important, and can be fairly well accomplished by guiding the point in the same plane as that of the surface of the hone when applying the finishing touches. The last operation consists in accurately adjusting the distance from the point or stylus to the center of the hatchet edge to 10 inches, by slightly bending the steel more or less at the angles. The length of 10 inches is preferable for general work, not only because it is a handy length, but also because it reduces the arithmetic. Five inches, or any other convenient length may be taken if preferred.

Having completed the instrument, the method of using it is shown in Fig. 2. Fix the diagram on a flat board, such as a drawing board or table, and pin down also a sheet of smooth paper (preferably on the further side of the diagram) at such a distance that the hatchet edge will not run off the paper when tracing around the diagram with the stylus. Guess the position of the center of gravity of the diagram, and draw a line from it to the boundary of the latter. Then place the stylus on the assumed center of gravity, and gently press the hatchet so as to make a slight indentation in the paper. Now, without lifting the planimeter, trace round the diagram with the stylus, finally returning to the starting point; when this is reached, again press the hatchet so as to mark the paper. Without lifting the planimeter, and keeping the point pressed down on the diagram, rotate the diagram through about two

right angles, fix it, and again trace around its boundary, but this time in the opposite direction. Finally, having returned to the center of gravity, press the hatchet into the paper for the third time.

There will now be three marks, as shown in Fig. 2, at 1 and 3 and 2, the first and last close together, and the intermediate one at a distance from them. Measure the distance between the distant mark and the mean of the other two as accurately as possible with a pair of dividers, and multiply this distance by the length of the planimeter; the result is the area of the diagram. From this the mean height can be found, by dividing the area by the length of the diagram.

It is to be noted here that starting from the center of gravity of the figure or diagram is essential to success; if this is not done, serious errors will be incurred, rendering the meas-

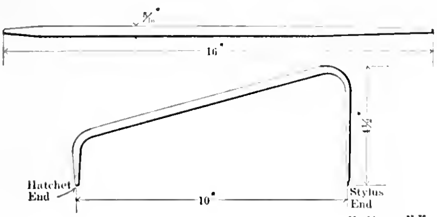


Fig. 1. The Hatchet Planimeter.

urement quite useless. Rotating the diagram through two right angles and going round it in the opposite direction, is done in order to correct for the inaccuracy of the original guess at the position of the center of gravity. But it is not always sufficient to make this correction. It is not easy to make the hatchet edge exactly in line with the stylus; this error can be detected by placing the hatchet and stylus on a penciled straight line, and drawing the stylus along the line, when the hatchet will be found to gradually run off the line unless the alignment is perfect. On account of this the writer finds it preferable to trace around the diagram in each direction before turning it round, and again after doing so. This gives four values for the displacement of the hatchet, the mean of which is taken with the dividers.

The latter measurement is important, as any error in its determination reappears in the result; it is best made therefore with a pair of fine dividers, and read off on a diagonal scale in, say, 0.04 of an inch. When a 10-inch planimeter is used, and the area of the diagram is small, the displacement of the hatchet is also small, and in this case a great increase in accuracy can be obtained by going round the diagram sev-

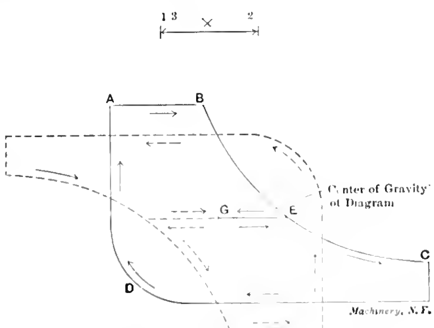


Fig. 1. Method of using Hatchet Planimeter.

eral times in one direction, then the same number in the other, and dividing the result by the number of times. By using a shorter planimeter, the displacement of the hatchet is proportionately increased; and if the length of the planimeter is the same as that of the diagram, the mean height of the latter is given at once by the displacement of the hatchet; the writer, however, prefers to use the 10-inch instrument for all purposes, and thinks that a shorter length than 5 inches should not be used.

By adopting the precautions described above, with a carefully made planimeter, an accuracy of 0.5 per cent is easily obtained, and this is usually a higher degree than necessary, for few diagrams are reliable to 1 per cent. The process appears far more complicated than it is in reality; in fact it is extremely easy and simple.

In conclusion it is important to observe that the paper on which the hatchet works is hard and smooth; that the planimeter is held upright while tracing, and that the point accurately follows the boundary of the diagram. This, of course, applies equally to all planimeters. If at the first attempt a high degree of accuracy is not attained, do not be in a hurry to blame the instrument; a planimeter needs practice, like any other measurement, before accuracy can be assured. It is a good plan to draw a right-angled triangle or a rectangle of dimensions similar to those of the diagrams to be measured, ruling in the lines with a hard pencil until there is quite a distinct groove, in which the point of the planimeter will run without deviation; then trace this repeatedly, first in one direction and then in the other, and measure accurately the displacement of the planimeter hatchet each time. If the hatchet and point are in correct alignment, and the lines are closely followed, the displacement will be exactly the same, no matter which way the point goes round the diagram; and if the start is always made from the center of gravity, the result will be independent of the position of the diagram. The hatchet should be fairly sharp, and curved to a radius of about ⅛ inch.

ON THE STRESSES THROWN UPON BOLTS BY THE WRENCH.

The Locomotive, July, 1905.

It is impossible to make any accurate computation of the tensile stress that is thrown upon a bolt, by screwing up a nut upon the end of it; but it is possible to obtain a roughly approximate estimate of that stress, when the nut is set up under given conditions.

Let us suppose that a given screw is provided with a nut, which is to be turned up solidly against some resisting structure, so as to throw a tensile stress on the screw. Let the nut be turned by means of a wrench whose effective length is L inches. When the nut has been brought up pretty well into place, let us suppose that a force of P pounds, when applied to the end of the wrench in the most effective manner, will just move it. The work done by the man at the wrench, per revolution of the nut under these circumstances, is found by multiplying the force P, by the circumference of the circle described by the end of the wrench. The wrench being L inches long, the circumference of this circle is $2\pi L$ inches, where π stands for the decimal number 3.1416. Hence the work performed by the workman, per revolution, is $2\pi LP$ inch-pounds. Let us assume, for the moment, that the screw runs absolutely without friction, either in the nut, or against the surface where the nut bears against its seat. Then the work performed by the workman is all expended in stretching the screw, or deforming the structure to which it is attached. Hence if the screw has n threads per inch of its length, and T is the total tension upon it in pounds, the work performed may also be expressed in the form $T \div n$; for in one turn the screw should be drawn forward by $1 \div n$ inch, against the resistance T. Under the assumed conditions of perfection, the two foregoing expressions for the work done must be equal to each other. That is, we should have $2\pi LP = T \div n$, or

$$T = 2\pi nLP.$$

from which we could calculate the tension, T, on the bolt, if the screw were absolutely frictionless in all respects.

We come, now, to the matter of making allowances for the fact that in the real screw the friction is very far from being negligible. The actual tension that the given screw would produce in the belt will be smaller than the value here calculated, and the fraction (which we will denote by the letter E) by which the foregoing result must be multiplied in order to get the true result is called the *efficiency* of the screw. The efficiency of screws has been studied both experimentally and theoretically; but the experimental data that are at present available are far less numerous than might be supposed, considering the elementary character and the fundamental importance of the screw, in nearly every branch of applied mechanics. In the *Transactions* of the American Society of Mechanical Engineers, Volume 12, 1891, pages 781

to 789, there is a paper on screws by Mr. James McBride, followed by a discussion by Messrs. Wilfred Lewis and Arthur A. Falkenau, to which we desire to direct the reader's attention. In this place Mr. Lewis gives a formula for the efficiency of a screw of the ordinary kind, which appears to be quite good enough for all ordinary purposes, and which may be written in form

$$E = 1 \div (1 + nd),$$

where d is the external diameter of the screw. If we multiply the value T, as found above, by this "factor of efficiency," the value of T, as corrected for friction, becomes

$$T = \frac{2\pi\, nLP}{(1 + nd)}$$

As an example of the application of this formula, let us consider the case in which a workman turns up a nut on a two-inch bolt, by means of a wrench whose effective length is 50 inches; the maximum effort exerted at the end of the wrench being (say) 100 pounds. A standard two-inch bolt has 4.5 threads per inch; so that in this example the letters in the foregoing formula have the following values: $n = 4.5$; $L = 50$ inches; $P = 100$ pounds; $d = 2$ inches; and π (as usual) stands for 3.1416. Making these substitutions, the formula gives

$$T = \frac{2 \times 3.1416 \times 4.5 \times 50 \times 100}{(1 + 4.5 \times 2)} = \frac{141.372}{10} = 14{,}137 \text{ pounds.}$$

That is, the actual total tension on the bolt, under these conditions, is somewhat over 14,000 pounds, according to the formula. As another example, let us consider a screw 1.5 inch in external diameter, with the nut set up with the same force and the same wrench as before. A standard screw of this size has six threads to the inch, so that the formula gives in this case,

$$T = \frac{2 \times 3.1416 \times 6 \times 50 \times 100}{(1 + 6 \times 2)} = \frac{188{,}496}{13} = 14{,}500 \text{ pounds.}$$

or a total tension on the bolt of 14,500 pounds.

CASTING IN METAL MOULDS.

Walter J. May, in the Mechanical World, June 3, 1905, p. 203.

There is nothing very new or striking in the use of metal moulds in foundry work, yet there are openings for fresh uses for metal moulds in some directions, particularly with some of the softer and more-easily melted alloys. Where iron is concerned, metal moulds or parts are used as "chills" for various purposes, the castings being made of metal which possesses the property of chilling to a more or less great depth. The whole surface, or parts of the surface only, may be chilled and hardened, and the treads and flanges of car-wheels and the like may be chilled, while the other parts are left as soft as the character of the iron used will permit. Larger use could be made of chills in the production of hardened work than is at present the case, especially where friction has to be provided against; but very probably the hardness of chilled metal and the trouble in tooling it prevent its more extended use. At the same time there is no reason why chilled iron should not be ground to shape, while for many purposes grinding is far cheaper than other methods of machining metals. In all cases the metal moulds, or "chills," should be faced up properly, and when used for casting, a coat of plumbago, charcoal, or other protective material should be put on the surfaces which come in contact with the molten metal.

In rolling and tube-drawing mills making their own strip and tube ingots, metal moulds are used, and under the ordinary conditions of the casting shop give good results. The moulds are coated with chalk, plumbago, steatite, or other material, and when dry are poured on end; and while occasionally spilly metal occurs, yet generally sound castings, well fitted for the purposes to which they are put, are produced. The moulds should be of good iron, and should be very smoothly cast, or machined smooth, while the coating of carbon or other matter should be applied evenly, otherwise the metal ingot produced will not be smooth on the surface.

With lead and soft metals of this class, bronze, brass, and iron moulds are generally used where large numbers of the same article are needed; and provided the moulds are kept brushed out with plumbago or steatite, the castings come out with a smooth and finished surface. Bullets, toy soldiers, and such like things are turned out by the thousand from metal moulds; and where the metal is hardened, as in the case of type metal, very strong toys are produced. Type is cast in metal moulds, whether it be made by hand in the old-fashioned way or in machines, as in the Wicks rotary type caster, and others; and, of course, the linotype machines use metal moulds—matrices—of a movable character for forming the lines of type, or "slugs," as they are termed in printers' parlance. The moulds have to be very carefully made for fine and precise work, but metal moulds give finished results in these cases, and results such as could only be obtained with much labor if the moulds were roughly made. There is, however, no reason why metal moulds should not be more largely used for repetition work in soft metals, even aluminium casting very well for many patterns; but the greater the amount of contraction in any metal, the less suitable is it for use with metallic moulds, except they be of the simplest form, as in the case of ingot moulds.

Perhaps for certain classes of work in brass, well-finished metal—iron—moulds would give financial results superior to sand moulds. For instance, in some forms of gas-fitting ornaments and the like; as, properly done, only the minimum amount of finishing would be necessary. With articles of such a form as could be readily dealt with in the lathe, ordinary moulding would be cheaper and probably better, the cost of finishing such work being small; but where work difficult to finish is dealt with, the matter would be different, as with good moulds only the smallest amount of filing would be necessary. Given smooth, well-finished moulds, coated with steatite or plumbago and poured with clean brass at a fairly low temperature, castings quite smooth enough for dipping should be produced, and hundreds of castings could be obtained from a cast-iron mould, or with a forged wrought-iron mould thousands of castings could be made, there being no danger in cooling the moulds. Some difference in practice has to be overcome in dealing with metal moulds, but this presents no serious difficulty if one means to succeed.

The advantage of using metal moulds for large lots of small and medium-sized castings is in the saving in skilled labor in moulding in sand, as with a sufficiency of moulds two men and one or two boys will cast more metal in a week than a dozen moulders can turn out, and this with very little teaching. Of course, the proper melting of the metal must be known. but this is not difficult for an intelligent man to get a hold on, although alloying is more difficult; but even this is easily learned when the proportions of the different components of an alloy are given. For large numbers of castings the advantage of permanent moulds in maintaining uniformity in the castings is also a matter of moment, and particularly as with carefully made and prepared moulds many classes of work would require practically no finishing before being ready for paint or other decorative application to be put on. In fact, from many points of view the reductions in cost would be such that it would pay for the comparatively heavy costs of the moulds, as only one expense would be made against the many expenses in moulding in sand.

The disadvantages would consist in the inapplicability of the use of metal moulds for small numbers of castings, and to the limits of size which would of necessity take place. The form of the castings would have to be fairly simple so that they would shrink away from the mould, and not on to parts of it, and this to some extent limits the application of permanent moulds. Cores could be readily used in the majority of cases, provided they were well made, and the moulds could be in more than two parts if well fitted.

There is a wide field still open for the use of metal moulds in casting a wide range of metals and alloys, and the subject is well worth the attention of makers of large numbers of cheap castings of similar form, the cost of cast-iron moulds not being prohibitive. Some moulds could be made with fine skins on the shaped portions, so that machining or other

tooling would be unnecessary except at the joints, the iron being cast with either a smooth or grained surface, as needed; but of course the cost of fine castings is higher than that of the ordinary work which has to be machined. The writer has cast iron moulds for various alloys which have not needed any machining, and the castings from such moulds have come out quite smooth on the face and sharp in detail; but all cast-iron moulds could not be so well done.

WATER GAGES FOR STEAM BOILERS.

Portefeuille Economique des Machines, November, 1904, p. 161.

The principal qualities that a water glass must possess are visibility, ease of cleaning, and ease of replacement. Visibility depends to a great extent on the location of the apparatus. But in spite of the fact that it is seldom far removed from the fireman, various devices have been resorted to to increase the distinctness of the water line. The one most frequently

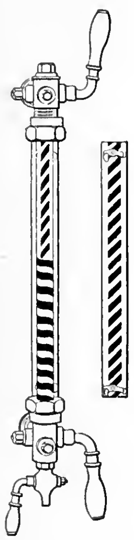


Fig. 1. Cooper Bended Water Glass.

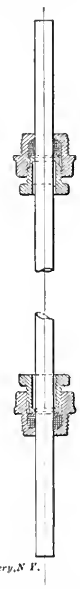


Fig. 2. Berthelot's Removable Packing Boxes.

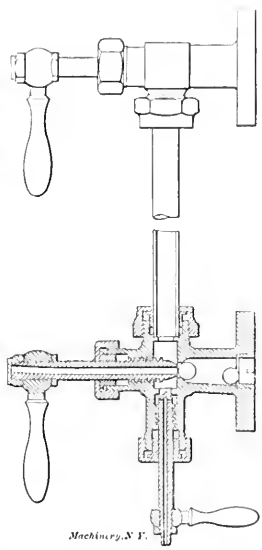


Fig. 4. Dumay Gage Cock with Hollow Handle for Cleaning.

used is that of a red longitudinal band, which appears narrow above the water line and broad below it. There is danger, however, that the incorporation of a red band into the body of the glass will destroy its homogeneity, injure the uniformity of its expansion and render it liable to crack. The red band has also been applied to the outside of the glass, either in contact with it or with a space between.

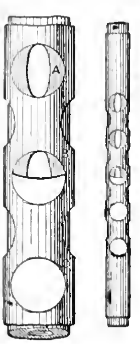


Fig. 3. Carre's protected Water Glass.

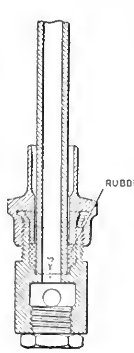


Fig. 5. Glass Mounting with Packing too low.

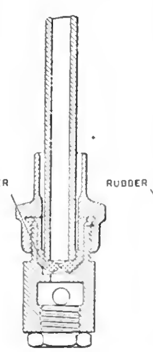


Fig. 6. Effect of low Packing

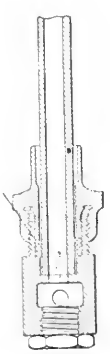


Fig. 7. Preferred Arrangement for Figs. 5 and 6

Instead of the continuous band, one broken by non-colored intervals has been used, the effect of which is shown in Fig. 1; an effect that is due to the combination of the optical properties of the glass and the water.

Carré's water glass is covered with a metallic shield in which there are three circular openings, the effect of which is that where the water is below the hole the latter appears as an ellipse with the major axis vertical. Where the water level is above the top of the hole, the latter shows a full circle and where it cuts through the hole the latter shows a full circle at the lower part and an eclipse with the major axis vertical at the upper, as shown in Fig. 3.

The passages of the tube and cocks gradually become coated with scale and they would soon be sealed were they not cleaned from time to time. That this may be done with ease the Dumay gage cock has a hollow handle with a cap over the outer end, as shown in Fig. 4.

Water glasses should be arranged so as to be quickly renewed whenever the inner surface roughened by the steam has lost any of its transparency, when the surface has become corroded, or the tube has been broken.

It is essential that the effects of broken tubes should be minimized and one of the most efficient means to this end is the use of a high grade of glass. There are some qualities of glass tubes that are quickly attacked by steam, the small drops of water that are condensed in the upper portion run down the inside and cut grooves in the glass so that the latter is gradually weakened, until the tube, no longer able to withstand the pressure, bursts. This can best be avoided by replacing the tube after a certain period of service.

Attention is also called to the fact that water glasses exposed to currents of air, as in the case of locomotives running backward, break more frequently than those that are always sheltered.

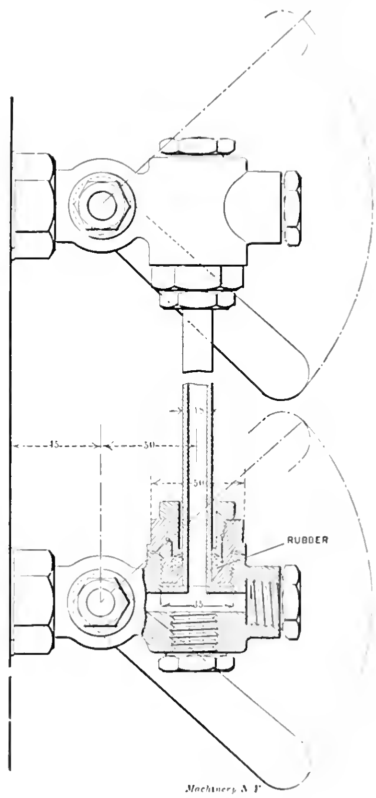


Fig. 8. Berthelot Removable Mounting

Manufacturers of glass tubes have, therefore, attempted, by the use of special materials and carefully worked-out methods of manufacture which include the tempering and annealing at well-regulated temperatures, to produce a glass that will resist sudden variations of temperature, the attacks of steam and the effects of pressure. In this they have succeeded so well that tubes are on the market to-day that have a tensile strength of 5,000 pounds per square inch of section and which will carry with safety an internal hydraulic pressure of 5,700 pounds, or a steam pressure of 450 pounds. Such tubes have a durability that fully makes up for the high price charged for them.

Defective mounting is one of the most prolific causes of broken water glasses. When a new tube is put in place the packing is sometimes badly centered or carelessly adjusted, so that the glass comes in contact with some of the metallic parts. The result is that an attempt to stop a slight leak by screwing down the gland, but which the slant of the glass increases, ends in a fracture. Sometimes the packing slips beneath the tube, thus checking all possibility of expansion and is a sure precursor of breaking. This often occurs also when the stuffing box comes down too low, as in Fig. 5. The

packing is then likely to get into the position shown in Fig. 6. In order to avoid this inconvenience it is well to make the stuffing box of the shape shown in Fig. 7. If necessary, the depth of this chamber can be decreased by putting a brass ring in the bottom.

The replacement of water glasses can be very quickly effected by the use of the design shown in Fig. 8, with which the stuffing boxes can be put in place while the glass is held in the hand and the boxes afterward screwed into place.

The use of a connecting pipe or water column between the two points where steam and water respectively are taken from the boiler diminishes the amount of condensation in the latter and with it the wear, while the amount of scale deposited in or near the tube is also lessened.

There is a difference of opinion as to the use of a cock or a valve worked with a screw, for cutting off the connection between the boiler and the glass.

The latter is preferred on account of the ease of manipulation, while the former sometimes sticks. On the other hand, the cock is much more rapidly closed. G. L. F.

* * *

BEAM FORMULAS.

SANFORD A. MOSS.

In the data sheet accompanying this number is an extensive table of formulas for the stresses and deflections in beams, shafts, etc. Below are partial tables of the properties of materials, and of cross-sections. These latter tables are readily accessible in the various mechanical handbooks, etc., so that completeness is not here aimed at. No table of formulas for stresses and deflections has ever been given, however, which completely covers usual cases, and the present data sheet table is an attempt to supply the deficiency. It is probably the most complete one ever published.

The explanations accompanying the tables are such that any one may use them, without previous knowledge of the subject. All details are covered by the three tables, in a form convenient for quick and ready reference. It is not requisite that one have the details of procedure at one's finger-ends in order to quickly solve a problem, as is the case with most tables on this subject. Especial pains have been taken to reduce the formulas to that form most convenient for use in computations.

The formulas have all been worked out from first principles especially for this publication, and carefully checked so as to eliminate errors. Care has also been taken to avoid typographical errors, which make many simliar tables unreliable.

Table I. Properties of Materials used for Beams.

This table gives a partial list of *average* values. Authorities differ very widely as to the proper values, and it may be often desirable to use other values than those here given.

MATERIAL.	E, Modulus of Elasticity, lbs. per sq. inch.	s, Maximum Safe Stress, lbs. per square inch. For Dead Load, *i. e.*, one which never varies.	For Live Load, *i. e.*, one frequently varying from Zero to Maximum.	For Reversing Load, *i. e.*, one Alternately in Opposite Directions.
Cast iron, tension....	17,000,000	3,000	2,000	1,000
Cast iron, compression	17,000,000	12,000	8,000	1,000
Wrought iron	27,000,000	15,000	10,000	5,000
Mild steel	29,000,000	16,500	11,000	5,500
High carbon steel (oil tempered)....	29,000,000	21,000	14,000	7,000
Nickel steel (oil tempered)	29,000,000	45,000	30,000	15,000
Steel castings (annealed)	29,000,000	12,000	8,000	4,000
Manganese bronze...	14,000,000	15,000	10,000	5,000
Phosphor bronze, aluminum bronze, etc.	14,000,000	10,000	6,600	3,300
Bronzes or gun metal (copper-tin alloys)	12,000,000	4,200	2,800	1,400
Brasses (copper-zinc alloys)	12,000,000	3,000	2,000	1,000
Copper (rolled or drawn)	16,000,000	3,000	2,000	1,000
Wood (average)	1,500,000	1,500	1,000	500

Table II. Properties of Cross-sections of Beams.

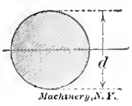
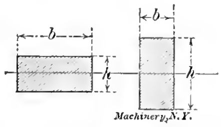
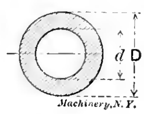
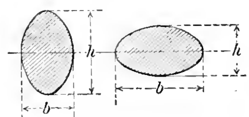
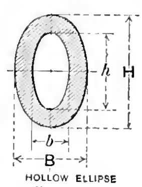
All Dimensions in Inches.

The following is a partial table, containing usual cases. More complete tables will be found in various engineering reference books. The quantity Z, here called the "Section Modulus," is often called "Moment of Resistance," or sometimes simply "Resistance." Values of the Moment of Inertia and Section Modulus for I-beams and other rolled shapes are given in the handbooks issued by the various steel companies.

The *Axis* of the cross-section is that line through its center of gravity perpendicular to the plane in which the beam is bent. It is indicated by a broken line in the figures below. The Moment of Inertia and Section Modulus for a given section vary according to the axis, and care must be taken that the proper value is used.

The *Moment of Inertia I* of a cross-section, with respect to a given axis, is the sum of the products found by multiplying the area of each element by the square of its perpendicular distance from the axis.

The *Section Modulus Z*, of a cross-section with respect to a given axis, is the quotient I/c, where c is the perpendicular distance of the outermost fiber from the axis, and I is the moment of inertia with respect to the same axis.

Section. All dimensions in inches.	I. Moment of Inertia. (inches)^4	Z. Section Modulus. (inches)^3
	$\frac{\pi d^4}{64}$ or $.04909\, d^4$	$\frac{\pi d^3}{32}$ or $.09817\, d^3$
	$\frac{b h^3}{12}$	$\frac{b h^2}{6}$
	$.04909\,(D^4-d^4)$	$.09817\,\frac{D^4-d^4}{D}$
 ELLIPSE	$.04909\, b h^2$	$.09817\, b h^2$
 HOLLOW ELLIPSE	$.04909\,(B H^3-b h^3)$	$.09817\,\frac{(B H^3-b h^3)}{H}$

* * *

HIGH PRICES NINETY YEARS AGO.

At this time, while every one is complaining of high prices and almost all trades are endeavoring to get wages raised, it is interesting to note what the price of groceries were ninety years ago. In a recent consular report Marshal Halstead, U. S. Consul at Birmingham, England, quoted from an old price list of 1814 which shows that the price of tea, coffee, sugar, figs, raisins, rice, were from 50 to 600 per cent. higher than now. For example, tea was quoted at $1.74 to $2.68 for the same quality which can now be purchased for 40 cents per pound; coffee, 49 to 67 cents for which 40 cents is now paid; sugar was 36 cents, present price 6 cents; figs, 23 cents, present price 8 cents. These prices are for English markets. It is pointed out that one reason for the very high prices on some commodities in 1814 was the risks attendant to ocean transportation before the days of steamships..

IMPORTANCE OF GOOD CLAMPING FACILITIES IN MACHINING LARGE WORK.

G. Q. ROSS.

I enclose some cuts of machine tools which illustrate clearly the methods used at the works of the Bullock Electric Mfg. Co. for rapidly and rigidly chucking their large work. About one year ago this company started the introduction of the bonus system throughout their plant with the intention of gradually doing away with the premium system which had been for a number of years, and in fact is at the present time, in successful operation, the claim made for the bonus system being that it would enable the foremen to know where the weak points in their methods were, and consequently where the time was being lost. So far as determining this information was concerned the system was a decided success, and had it not been for the immense amount of clerical work required to make out the "operation" cards, would have been adopted in place of the premium. It was an easy matter to figure the speeds, feeds, number of cuts, etc., on a given piece and comparatively easy to see that the workman kept up to the mark, but the total time consumed on a job of any size was always about double what was "figured out."

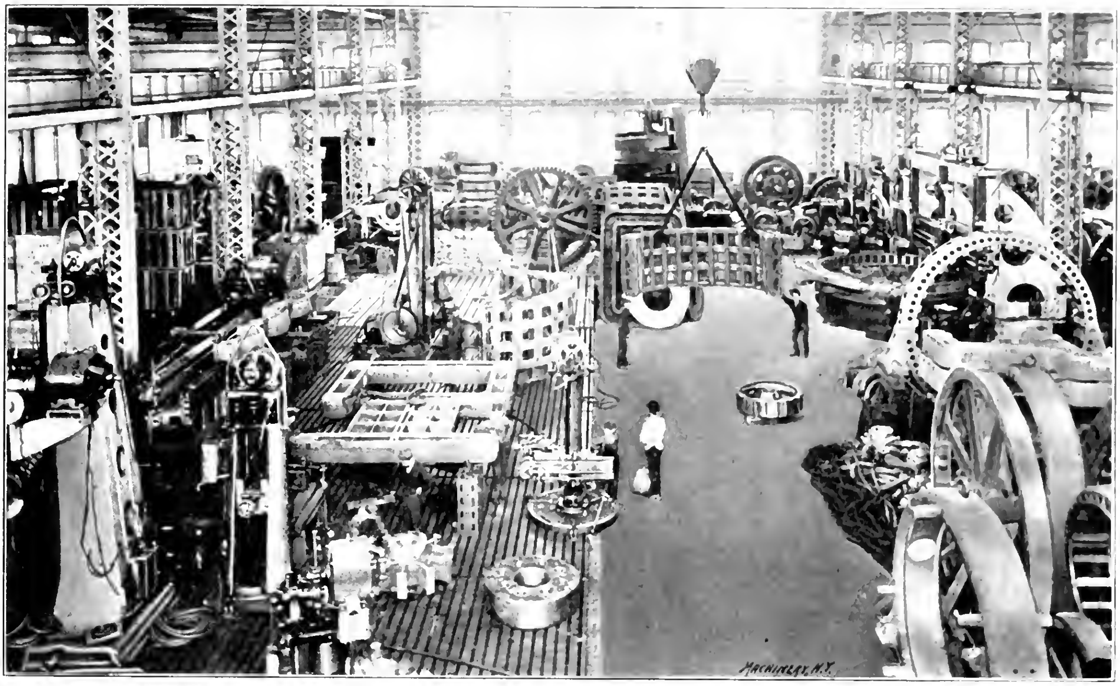


Fig. 1. General View of a Bay in one of the Bullock Electric Mfg. Co.'s Shops, showing Floor Plates and Portable Tools. The Work is such that the Time Spent in Setting up is an Important Consideration.

Upon investigation it was found that the entire time was consumed mostly on account of a poor supply of the most common accessories of a machine shop, such as clamps, dogs, drivers, chucks, wrenches, cutting tools and bolts, nuts, washers, heel blocking, etc. Although bolts with forged T-heads had been bought by the hundred, it was almost impossible to find one, when needed, with a good head, good thread, and of the proper length.

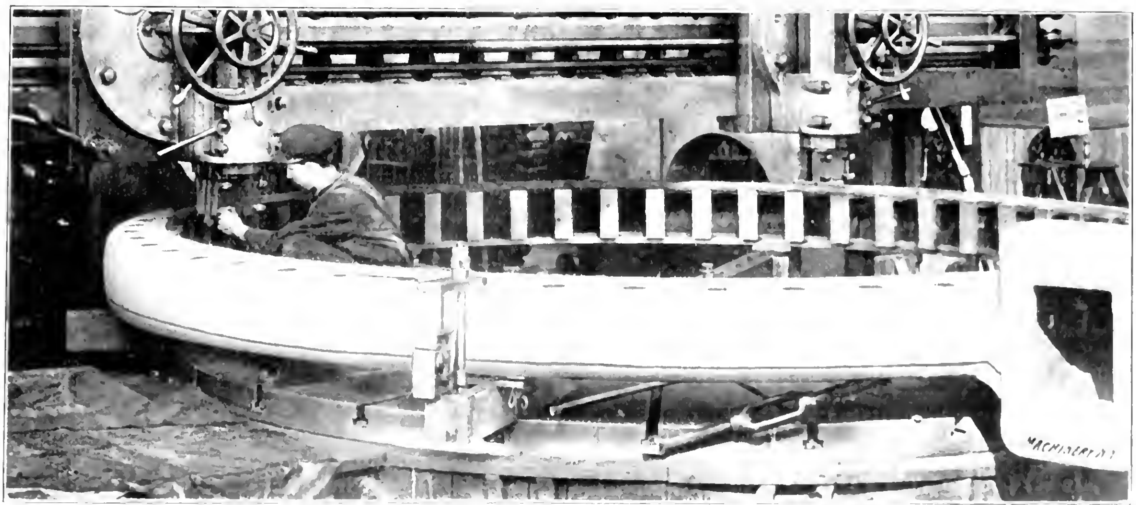


Fig. 2. Generator Frame on Boring Mill Table, showing Method of Holding Work

Having found out where the greatest leakage was, it did not take long to decide that the junk heap around the machines must go. In its place each machine was equipped with a bolt and clamp box, supplied with from 1 dozen to 2 dozen steel T-heads,* and from 3 to 12 dozen studs ranging from

* These T-heads are made by G. R. Lang Co., Cincinnati, Ohio.

3 inches to 36 inches in length, and these, supplied with nuts and washers, settled the bolt question for good. This being settled, the next move was to rid the machines of all the wooden blocking used around the shop. In their places were made turnbuckles with forked stub ends (to be used as drivers and braces) and cast iron heel blocks made in the form of a step. These were not only quicker to set up than the wooden ones but enabled the work to be held more rigidly and to stand stiffer cuts and feeds. Each machine was supplied with its own equipment throughout and nothing was allowed to be taken from one machine to another without the consent of the foreman.

The results were simply astonishing. The men took more interest in their work and showed it by the way they turned it out. The strange part of this is that it is nothing new; the men had been kicking for something to work with and instead of giving them what they needed we went hunting after "systems." After some years experience with handling men I find that the only successful system is the one which gives the man a square deal and doesn't expect him to say "peace" when there is no peace, nor find bolts when there are none to be had. I trust this will be of interest to your readers and bring out other points along the same line.

* * *

HIGH-SPEED PLANERS.

Editor MACHINERY:

We regret that Mr. A. L. DeLeeuw did not extend his investigation of the high-speed planer problem to an examination of the Chandler Planer before committing himself to the opinion and predictions made in the article that appeared over his name in the June number of MACHINERY.

We further regret that he has been unable to accept our invitation to visit our shop and subject the Chandler Planer to as many and as protracted tests as he shall deem necessary to satisfy himself that our claims are justified.

The subject of high-speed planers, as treated by Mr. DeLeeuw, divides itself, so far as belt-driven planers are concerned, into four headings:

I. Has a practical high-speed belt-driven planer been built?

II. Is the result sought by such a planer worth the effort?

III. What are the obstacles in the way of the solution?

IV. What other features besides high speed must a planer possess to be a commercial and mechanical success?

I. Has a practical high-speed belt-driven planer been built?

Mr. DeLeeuw says "The planer problem [high speed] has been attacked a number of times,, by a number of persons, but with indifferent success." The Chandler planer is running, and is guaranteed to run, without sacrificing any feature of efficiency that Mr. DeLeeuw will name, at any cutting speed from 25 feet per minute to 60 feet per minute, with a return speed of 200 feet per minute. At the Fore River Shop Building Co.'s shops, Quincy, Mass., a Chandler planer is running at a cutting speed of 90 feet per minute with a return speed of 150 feet per minute.

What the Chandler planer is doing is such a flat answer to Mr. DeLeeuw as to excuse our protracting this article further. This subject is too important to be treated dogmatically, however, and we shall therefore answer Mr. DeLeeuw's arguments specifically and in detail.

II. Is the result sought by such a planer worth the effort? or, as Mr. DeLeeuw puts it, "Is the flame worth the candle?"

He expresses the opinion that using a high-speed planer is equivalent to hunting a rabbit with a six-inch rapid-fire gun. To substantiate that conclusion he supposes a cutting speed of 20 feet per minute, with a return speed of 80 feet per minute, and computes that increasing the return speed from 80 feet to 100 feet would save four per cent. That four per cent seems to be *his* rabbit. But if the return speed should be increased, not from 80 to 100, but from 80 to 200 feet, there would then be a saving of 12 per cent. If the cutting speed is 50 feet and the return speed should be increased from 80 to 200 feet, there would then be a saving of over 23 per cent. If the cutting speed is 65 feet and the return speed should be increased from 80 to 200 feet there would be a saving of over 27 per cent. Thus, contrary to the popularly accepted idea, the value of a quick-return increases with each increase of the cutting speed.

We submit that there is meat enough in that rabbit to justify the use of a six-inch rapid-fire gun. The results that we have obtained are not those of merely exhibition tests, but are, in many cases, prescribed by our customers. Here is an instance: At the request of the superintendent of the United Shoe Machinery Co., we roughed and smooth-planed a thin cast-iron test plate 12 x 48 inches with one tool point on a 24 x 24 x 6 foot planer in 17 minutes. We suggest that Mr. DeLeeuw put this job on some planer in which he has confidence, and report the results in these columns.

III. What are the mechanical obstacles in the way of high-speed planers?

We are under obligation to Mr. DeLeeuw for emphasizing the obstacles that, in his opinion and experience, stand in the way of a successful high-speed belt-driven planer. The various problems to which he refers were appreciated by Mr. Chandler from the first, and we submit that they have been overcome in his planer.

1. Pulleys. On our large size planers the speed of the tight pulleys exceeds the safety point of cast-iron pulleys, and we are aware that no commercial steel pulley fills the bill. Our high-speed tight pulleys are steel forgings of our own invention and construction. Their great strength permits increased speed, and their lightness reduces the momentum problem on reversal.

2. Shafts. We agree with Mr. DeLeeuw that no ordinary shaft can be run at the speed, and do the work we guarantee. All shafts in the Chandler planer are casehardened and ground. So far as we know, we are the only persons who have successfully casehardened pieces as large as planer shafts. With these shafts we have less difficulty at the high speeds than the ordinary slow planer has with the ordinary shafts. For the purpose of testing the shafts, we have repeatedly permitted them to run until they have become dry and heated and finally stuck, and then cooled them off, oiled them up, and started again. In no instance have the shafts cut.

3. Lubrication. All loose pulleys on the planer are fitted with grease cups and are guaranteed to run two weeks without re-filling.

4. Overcoming the shock of reversal.

We agree with Mr. DeLeeuw that bunters, buffers and friction clutches are all failures. The momentum and inertia to be overcome are in the rapidly running pulleys and gears and not at all in the platen. Mr. DeLeeuw's analysis is scientifically correct. We, therefore, grapple the problem at the long end of the lever. We accomplish the reversal by the belts, and in no place is a belt required to do any more than has been repeatedly and successfully accomplished from time immemorial.

We take the cutting speed as a basis, and we put it anywhere that steel will cut. Suppose the cutting speed is 50 feet per minute. At the end of the cutting stroke we make the best reversal we can, say two to one, which is our usual ratio of reversal from 50 feet. The platen starts back at a speed of 100 feet per minute. As soon as it is under way the tappet encounters another step on the reversing dog, and the reversing belt is thrown off, and the high-speed belt, which accelerates the platen speed from 100 feet to 200 feet—a relatively easy matter—is thrown on. At the end of the return stroke the belts are manipulated in reverse order; that is, the high-speed return belt goes off, and the reversing belt goes on. This brings the platen speed down from 200 to 100 feet per minute, from which it is easily reversed to the cutting speed.

IV. What features besides high speed must a high-speed planer possess to have an all-round commercial and mechanical value?

We agree with Mr. DeLeeuw that "It should plane slow or fast and return fast or slow without spending much time in changing drive."

A planer slow enough for all work is better than one that is too fast for some work. Some planers reduce the cutting speed by reducing the speed of the countershaft by a variable speed drive, but that process is cumbersome, apt to be slow in manipulation and is somewhat uncertain in results. Worse than all that, it reduces the speed and, therefore, the power

that is transmitted to the planer through the driving belts. The belt ratio should be greater on the slow than on the fast cuts, because usually the slow cuts are the heavier.

In the Chandler planer the speed reduction is accomplished by a back gear in the gear train, and is operated by a lever on the operator's side, so that either speed can be instantly and positively had while the planer is in operation. To change the speed of the return stroke the operator simply raises or lowers a latch on the reversing dog. This latch puts the high-speed belt into, or keeps it out of action, and is manipulated instantly.

Closely associated with the speed in high-speed planers is the question of feed control. Increased cutting speed, strength of planers and steels makes possible a wider feed range. At the same time, if the planer is running more rapidly there is an increased difficulty in manipulating the ordinary feed adjustment, and a greater per cent of loss for every minute the planer is idle. On the Chandler planer the feed is regulated by a controlling lever which determines the length of the arc through which the friction box moves. The feed is thus put into the immediate control of the operator, who has no excuse for not using at all times the feed best adapted to the particular work he is doing.

Mr. DeLeeuw's article is such a clear statement of generally accepted theories that to offset it with other theories would not be a practical answer. We have, therefore, confronted it with actual conditions and actual results. If our planer is capable of doing what we claim our answer is conclusive. He or anyone else may put it to the test, and if we have exaggerated we cannot escape the consequence of our misrepresentation.

George J. Burns,
General Manager of Chandler Planer Co.
Ayer, Mass.

This letter, in reply to Mr. DeLeeuw's extended article upon high-speed planers in the June number, was received last month, but too late for the August number.—Editor.

* * *

CROCKER-WHEELER-TERRY TURBO-GENERATING SET.

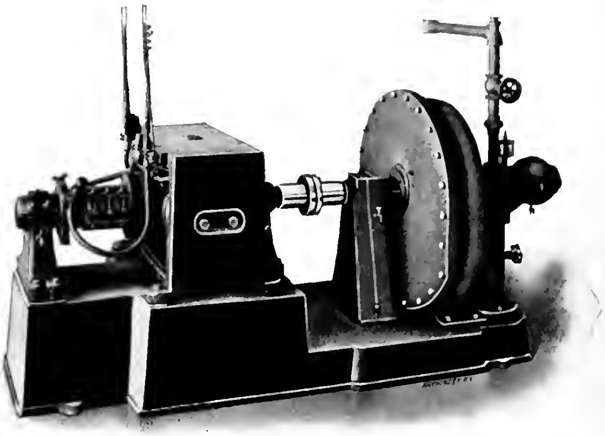
A 30 horse-power, steam turbine, direct current electric generating unit of novel design is shown in the accompanying illustration. The generator was designed and built by the Crocker-Wheeler Company, Ampere, N. J., and the turbine is the invention of Edward C. Terry, Hartford, Conn.

In the generator it was not found necessary to introduce any special features to help out the commutation, which is well taken care of by the standard Crocker-Wheeler design. The ring that carries the plain carbon brushes is provided with means for shifting them, but it has been found unnecessary to do so. The generator has carried loads ranging from zero to full load for many hours at a time without sparking. Overloads of 50 and 75 per cent have been carried for half an hour without sparking. A factor favorable to the sparkless commutation is the ample brush-contact surface.

A long commutator running at 2,500 revolutions a minute offers no small difficulties to the designer. This one is well within the safe limits, as was shown by running the completely wound armature at a speed of 4,500 revolutions a minute. A microscopic examination of numerous parts of the armature and commutator showed that the stresses in no part had approached the elastic limit.

In the turbine the force producing rotation is directed tangentially to the periphery of the wheel, completely avoiding end thrust. The velocity of the moving steam is not all absorbed in a single impact or in a single bucket. The buckets of the wheel are encircled by similar stationary buckets or reversing chambers, which return the steam to the wheel after each rebounding until all of its effective energy has been abstracted. The wheel consists of two steel disks secured to a cast-steel hub on the shaft and bolted near their circumferences, where they clamp the forged buckets. The reversing chambers are fastened to the case and are grouped in sets of four, each group being supplied by a separate jet. These sets are each operated by a valve, thus enabling one or more jets to be closed, and those in use to be used to their full capacity, when less than full load is required of the turbine.

The buckets and reversing chambers are essentially flat semi-cylinders, with their open sides facing one another. They are formed of plates on the broad sides, with curved walls set at right angles to the plates. These chambers are arranged in a circular series, lapping one upon the other in the form of a series of steps—that is to say, the axis of the



A Compact Turbo-generator.

several buckets and chambers are set obliquely to the circumference of the wheel. Their open edges are inclined at a slight angle with the axis of the shaft, so that steam, after being reversed in each chamber, is delivered to the next succeeding bucket, this being repeated four times. Steam issuing from the jet passes to the bucket, and from the bucket to the reversing chamber, back again to the bucket, etc., until finally it escapes through a crescent-shaped hole in the central part of the reversing chamber. The wheel being in motion, this action does not take place between the same reversing chamber and the same bucket.

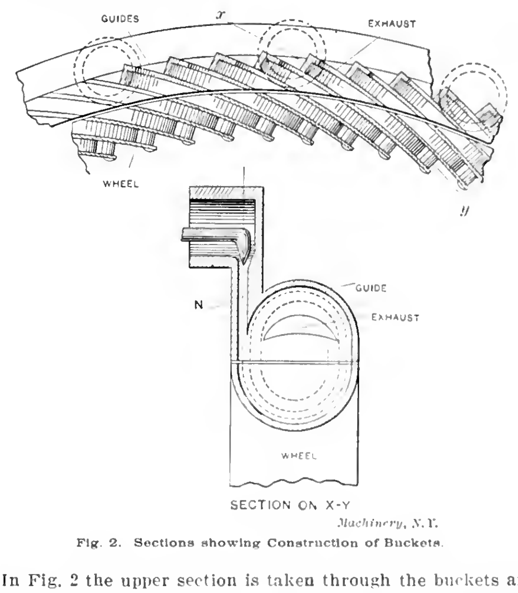


Fig. 2. Sections showing Construction of Buckets.

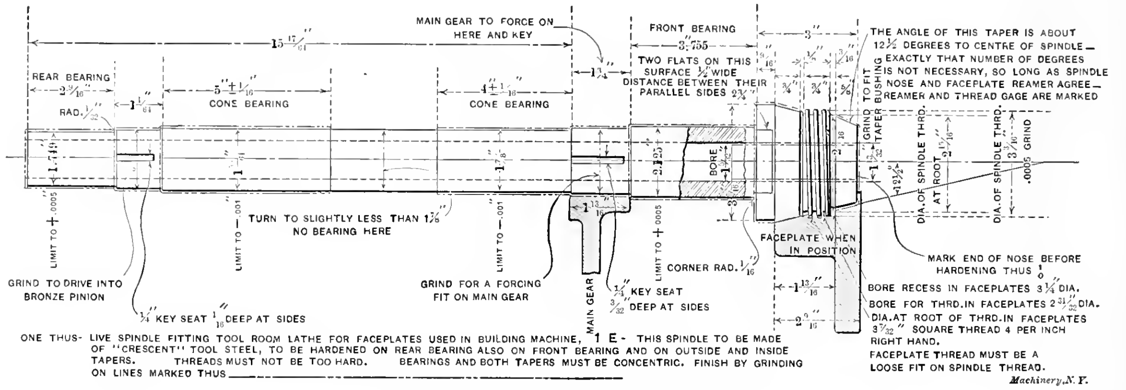
In Fig. 2 the upper section is taken through the buckets and guides in a plane at right angles to the axis and the lower section as taken on the line $x\,y$. Steam enters through the nozzle N and follows the course of the dotted lines until it escapes through the exhaust opening.

The turbine here shown has developed 30 horse-power with steam at 145 pounds pressure when operated non-condensing. Under these conditions the steam consumption was 32 pounds a brake horse-power an hour and the wheel made 2,600 revolutions a minute with a peripheral speed of 260 feet a second.

ITEMS OF MECHANICAL INTEREST.

SPECIAL LATHE SPINDLE.

Five or six years ago a Flather toolroom lathe in the shop of the George Gorton Machine Co., Racine, Wis., was fitted up with a special lathe spindle, as shown in the accompanying sketch, which we believe is of meritorious design. Its prominent feature is the nose, which is made tapering and is cut with a straight square thread of ¼-inch lead. The taper of the nose is about 25 degrees included angle, but as stated, the square thread is cut straight, and is made a loose fit. Hence, the moment that a faceplate is started, it is perfectly free to be twisted off by hand. Two flats ½ inch wide and 2¾ inches between their parallel sides are milled on the nose back of the faceplate fit for applying a wrench when necessary to start a faceplate loose. Obviously the construction is such that the tapered nose centers the faceplate exactly and no matter how many times a faceplate on which work is chucked is removed and replaced, it always centers exactly and runs as truly as though never removed, if ordinary precaution is taken to keep the nose clean. The design is the outgrowth of the needs of the shop for a lathe spindle on which faceplates could be removed and replaced or exchanged with the assurance that work chucked thereon would always center perfectly.



Spindle for Tool Room Lathe with Special Nose.

In reproducing the blueprint we have included the instructions of the draftsman which, as will be noted, are very copious and explicit. This is characteristic of the work of Mr. Carpenter, the chief draftsman of the company, as he believes thoroughly in the practice of making a drawing something more than a mere picture of the device to be represented; he regards a shop drawing as an instruction sheet which shall convey to the workman the fullest possible information as to the piece to be made and thus avoid any doubts or the need for verbal instructions.

TRAVELING HEAD PLANER.

Engineering, in a recent issue, gives a description of an interesting planer which has been built by Messrs. Joshua Buckton & Co., Ltd. The chief peculiarity of this planer lies in the fact that the table is stationary while the housings and tools move backward and forward, and in the fact that the tool holders are arranged to cut on both the forward and the return stroke. In this country at least such a construction is unusual. The planer has a capacity for work 6 feet wide by 4 feet high, and has a table 40 feet long. One great advantage of the moving housings and stationary table lies in the fact that work may be set up at one end of the table while the machine is operating on work at the other end. This does away with much of the lost time attending the operation of a large planer. The table of this machine has a cutting speed of about 40 feet a minute. Figures are given which show the advantage in point of economy of time of this arrangement of double acting tool holder over the usual arrangement of slow cutting stroke and quick return.

The firm for which this machine was built, who have been using it for some time, speak very well of the speed with which it does the work, the small amount of power consumed, and the stiffness of its general construction. One disadvantage of such a machine would seem to be the fact that the operator must travel back and forth with the moving housings to make the necessary adjustments; on the work, however, for which the machine was designed, such as surfacing locomotive frames, planing the tops of locomotive steam chests and other work which consists of large plane surfaces, this disadvantage would not be serious.

CONCRETE FLOORS IN FACTORIES.

In Report No. 17 of the Insurance Engineering Experiment Station, Boston, Mass., there is given some information on concrete basement floors which ought to be of value to machine shop owners. They have made an investigation into the use for this purpose of concrete, cement, and stone, in their various forms. They strongly advise against the use of a cellar in a shop building where it is not absolutely necessary. Such cellars and spaces are useless and noxious from every point of view and should never be tolerated unless rendered necessary for carrying shafting under the floors, usually a bad method. If such air spaces are provided they should be made as light as possible and should be ventilated, even if a forced circulation is required.

The true floor of a basement or of a one-story factory or work shop should be leveled up above the grade with gravel, sand, or rubble, and should be thoroughly drained. On this base a thick coating of tar, asphalt, or coal tar concrete should be spread. Trenches may be made in which timbers may be embedded in such concrete. When a plank floor is required it may be laid solid on the timbers with concrete, filled up and swabbed with coal tar so as to make a complete contact with the under side of the wood and so as to envelop the timber. Wood laid in this way on asphalt or coal tar products will last as long, or longer than any other wood in the mill. There have been examples under their supervision which have lasted for more than twenty years without noticeable deterioration.

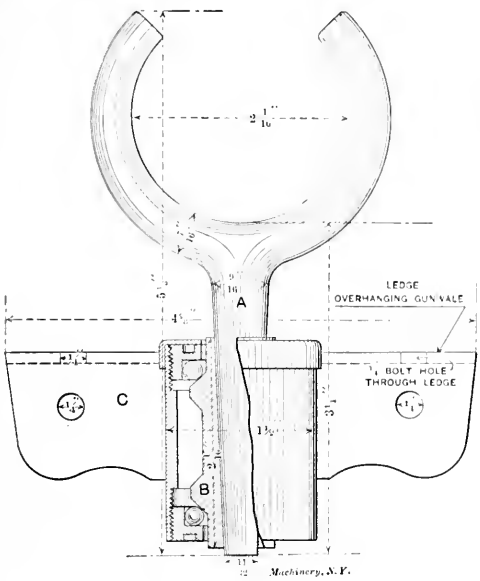
If a solid floor is needed without planking or timber, the concrete may be finished the same as sidewalks are now finished, and in some places concretes made with coal tar products are proving to be extremely serviceable in place of pavements on roadways. Since tank bottoms from the California oils and from coal tar products have lately displaced asphaltum, as we are informed, the products of coal tar are mostly in use in laying the floors. They are both antiseptic. They are non-heat conducting, impervious to water, and are therefore warm to the feet.

Cement concrete stone or artificial stone are not advised for basement floors or for the floors of one-story shops. They contain water in hygroscopic form. Wood laid in or upon such concrete is quickly destroyed. These materials are

ready conductors of heat and are therefore very cold to the feet. Under many atmospheric conditions they become absolutely wet; probably from the condensation of moisture from a warm, humid air.

A NEW USE FOR BALL BEARINGS.

Our occasional contributor, Mr. Arthur McAlpine, Auburn, N. Y., has sent us a blueprint showing a ball-bearing oar-lock which is being manufactured by a concern in Auburn. The cut is practically self-explanatory, so that little or no description is necessary. It will be observed that the thole-pin, *A*, is made with a tapered shank which fits into the ball-bearing sleeve, *B*. The frame *C*, on which *B* is mounted, is made with a ledge which fits over the gunwale of the boat and provides two additional bolt holes for attachment.



A Ball-bearing Oar-lock.

It will be clear from the drawing that the oar-lock can be instantly dismounted without in any way affecting the adjustment of the bearing. In other words, the ordinary construction is practically unchanged so far as use and appearances is concerned, but the bearing for the thole-pin shank is put on an anti-friction basis. This is said to make a great difference in the ease of rowing, and our correspondent says that it works so easily that it is a pleasure to row with this lock.

NOVEL PATTERN STORAGE SYSTEM.

The Brown Hoisting and Conveying Machine Co. of Cleveland, Ohio, have a pattern storage system which is very interesting. A brief description of it is given in the *Iron Trade Review*. The building is divided into comparatively narrow but high sections with fireproof partitions between them, and the patterns are stored on high narrow banks of shelves. To furnish easy means of access to these shelves a traveling crane has been installed in which the operator sits in a cage hung from the traveler, which can be raised and lowered the same as the hook in an ordinary crane. The operator thus has means of quick and easy access to any part of the storage shelves, and the storage space is kept very compact for the amount of patterns that is stored therein. The shelves themselves are made as nearly fireproof as possible, so that a small blaze would have difficulty in finding its way from one tier to another.

AN ELLIPSOGRAPH.

The unusual form of ellipsograph shown in Fig. 1 was constructed by Mr. J. J. Rexroth, 54 West Adams St., Chicago, Ill., and Fig. 2 shows examples of curves drawn with it. It comprises an annular stationary brass gear *D*, which is fixed on the drawing board, and a spur gear *C* having exactly one-half the number of teeth in *D*. To the spur gear is fastened an arm *B* across the diameter, to the outer end of which, in the position shown, is attached one arm of an ordinary wooden pantagraph. The fixture at *A* is adjustable on *B*, being shifted as the ratio between the major and minor axes of the ellipse is varied. The arm *B* has a slide pivoted in the middle of pinion *C* and engaged in the annular groove

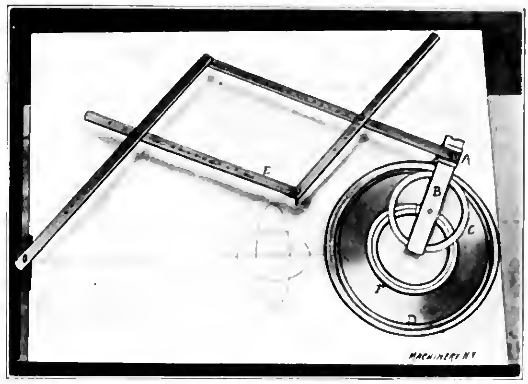


Fig. 1. An Ellipsograph.

in the ring *F*, which is attached to the back plate. The pivot in this slide thus forms a fulcrum around which *C* rotates and thus serves to hold it in mesh with *D* at all points of its travel. As stated, the ratio of the major and minor axes of an ellipse is determined by the position of slide *A* on the arm *B*. When *A* is coincident with the center of pinion *C* a circle is described as indicated at *F*, in Fig. 2. The axes of the ellipses are determined by the position of the arm *B* when radial; *i. e.*, whenever the axis of arm *B* coincides with

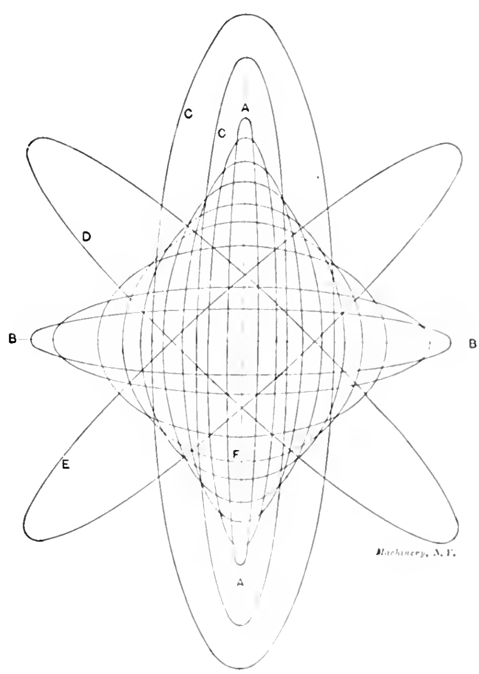


Fig. 2. Example of Work done with Ellipsograph

any radius of *D*, then the major axis of the ellipse will be found parallel to it; and the minor axis, of course, will be at right angles to it. When *A* coincides with the pitch line of *C* and *D* a straight line will be drawn as shown in Fig. 2 at *AA* and *BB*. In short, the device is an application of the well-known principle of the internal epicyclic gear having one-half the number of teeth of the external gear. The pantagraph provides the means for enlarging or reducing the motion to the desired scale.

LETTERS UPON PRACTICAL SUBJECTS.

KINKS FOR DRAFTSMEN.

Editor MACHINERY:

When the adjusting nuts on bow instruments become worn out, they can be squeezed onto the screw in a vise as shown in Fig. 1, and their useful life continued. This must be done very carefully or they will be gotten too tight. I fixed a bow pencil clamp once in a similar manner with a little piece of brass, perhaps 0.025 inch thick and 5-32 inch square, through which I made a hole as large as the screw and then squeezed it as above on the screw. A slightly bent corner kept it from turning.

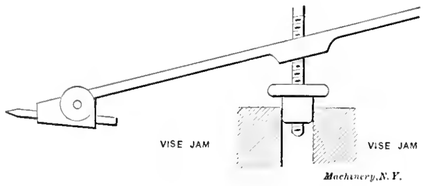


Fig. 1. Tightening a Worm Thumb-nut.

In place of a lost needle point, a fine sewing needle can be used by driving a hardwood sliver into the hole with it. The wood may protrude enough to act as a shoulder on the needle.

Celluloid Templets.

A very handy templet for drawing small curves and circles, where great accuracy is not required, may be made with a piece of thin celluloid. My templet, Fig. 1, is probably about 0.01 inch thick, and is a dark red tint, which is preferable to white. The circles are scratched deeply with bow dividers on one side, the center pushed through, and the same done on the other side until the piece can be broken out. By lightly scratching the center lines just beyond the outside of the circle before the center is removed, the hole can be located on center lines (see Fig. 2). On the edges, and particularly at the corners, are parts of circles with the center left and enlarged enough for the pencil point to go through to mark it. Sizes may be indicated by numbers giving the thirty-seconds of inch diameter. The holes should be cut slightly large to allow for

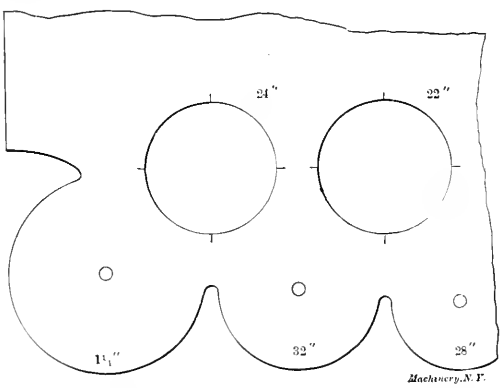


Fig. 2. Templet for Small Curves.

the pencil point; outside curves slightly small for the same reason. Similar templets may be made for the irregular shapes which are much used.

Special Scales.

A very convenient scale for one-half and one-quarter size work may be made by fastening strips of paper by shellac varnish just back of the graduations on a flat boxwood scale graduated full length with sixteenths on one edge and thirty-seconds on the other. On these strips mark the divisions and figure them, making the scale divisions equal eighths on the proportional scale (see Fig. 3).

I have similarly used a machinist's scale, with its advantage of deep graduations, by wrapping a strip of heavy paper lengthwise around the scale and fastening the two, with a screw at each end, on a beveled strip of wood, as shown in Fig. 4. With machinist's scales graduated to twentieths, twenty-fourths, twenty-eighths, etc., various odd proportions may be obtained.

Special scales may be made on paper or cardboard by laying off the larger divisions as convenient and making the shorter

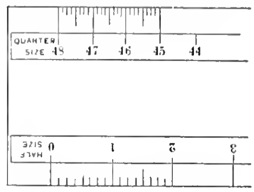


Fig. 3. Scale for One-half and One-quarter Sizes.

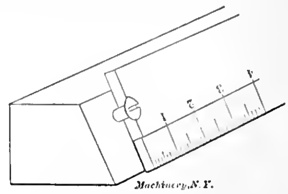


Fig. 4. Machinists' Scale adapted to Draftsmen's Use.

ones with a section liner. I have found very useful for this purpose one which consists of an old instrument screw turned into a slightly smaller hole in a piece of wood a little thicker than the diameter of the screwhead, and of such size that the two can be used in the central hole in a triangle as a block alone is sometimes used. The screw provides for a very fine adjustment of the spacing (see Fig. 5). Do not cut out the round corners in the triangle; it would cause a crack to start, if sharp.

T-square Tables.

One of the most convenient places for tables to which reference is often made, such as decimal equivalents, wrought iron

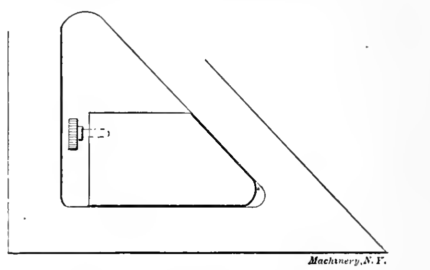


Fig. 5. Adjustable Section Lines.

pipe sizes, and screwthreads, is the T-square blade. They may be attached with shellac varnish and should be coated with the same.

Erasing Shield.

As an erasing shield I have never seen the equal of a very thin piece of sheet steel with slots cut with a small cold chisel and filed smooth. Mine is about .003 thick, I think, and the slots have not worn perceptibly large during eight years of use.

E. W. BEARDSLEY.

Waterbury, Conn.

CENTERING DEVICE FOR SCREW MACHINE.

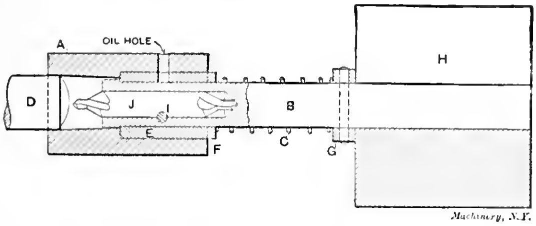
Editor MACHINERY:

Enclosed is a drawing of a screw machine fixture for centering piston pins, which I think will interest some of the readers of MACHINERY.

D is the piston pin, or any similar piece, in place in the chuck. The tool for centering it consists of a shank *B* gripped in a split bushing *H*, which fills the hole in the turret, a sliding sleeve *A* and a center drill *J*. The sliding sleeve is made with a tapered hole which fits over the end of the work *D*. As the turret is advanced the work enters this hole until it can go no further, and, as the motion of the turret slide still continues, *A* is then forced back against the pressure of spring *C*, revolving meanwhile with the work. It will thus be seen that the work is accurately centered with the drill. Continued motion of the turret brings the tool *J* into operation and the center is drilled to the proper depth as determined by the stop on the slide. Sleeve *A* is provided with a brass bushing *E* which forms its bearing on the shank, and has an oil hole drilled in it for oiling this bearing; the head

on the shank prevents the spring from forcing it off. A collar, *G*, held by a taper pin, furnishes the rear abutment for the spring. The center drill is held in place by a pin, *I*, put in Dutch key fashion. Care should be taken to get the pin in the center of the drill so that when one end is worn out and it is reversed to use the other, it will allow the same travel of the sleeve before the point enters the work, as before.

We use this fixture under a stream of oil, and after centering three or four pins we push the sleeve back and chips wash out easily. We make separate sleeves for different size pins,



Centering Tool for use on Screw Machine.

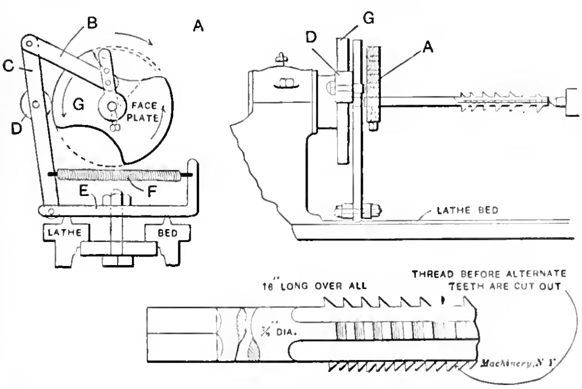
leaving the body of the fixture the same. This tool saves one operation on each end of the pin and also allows one end to be centered before cutting off, which, in turn, saves one chucking for each piece. It is unnecessary, also, to take a light cut over them in the lathe after centering, as was our former practice. The fixture gives satisfaction in every way.

Beloit, Wis. GERROLD HOWARD.

LATHE RIG FOR MAKING INTERRUPTED THREAD TAPS.

Editor MACHINERY:

We had occasion some time ago to make a number of interrupted thread taps for tapping a large number of steel nuts. A buttress thread was required, and we had found that using interrupted thread taps gave much better satisfaction, breakages being less, and less power being required for tapping. Then the question arose, how to make the taps quickly with the appliances at hand? We first ground out the alternate teeth, and then we chipped them out. Following that we put the taps in a lathe and used a lever on the faceplate to pull the tap around so as to cut out the alternate teeth with a tool held in a tool-post. Finally the idea was naturally suggested of making the lathe do the pulling, and I devised the simple rig shown in the accompanying cut.



Device for Cutting Interrupted Thread Taps.

A driver *A* was made for the taps, having an arm in which we tapped three holes for attaching the connecting-rod *B*. To the connecting rod was pivoted the rocking lever *C* which carried the roller *D*. The lower end of *C* was pivoted to a piece *E* which was clamped to the lathe bed, and which had one end turned up for the attachment of coil spring *F*. The parts *B* and *C* were made of ½ x 1¼-inch flat bar iron. *G* is an old faceplate of which we cut out two portions of the sides, as shown in the cut. In operation the spring *F* caused the roller *D* to follow the contour of the faceplate and rock the driver *A*, thus oscillating the tap back and forth as the faceplate revolved. The amplitude of the rocking motion of the tap depended upon the point at which the connecting-rod was attached to the driver *A*.

The taps were five-fluted, cut 8¾ threads to the inch. A 40-toothed gear was used on the leadscrew and a 71-toothed gear on the spindle. W. LOACH.

Davisville, Toronto, Ont.

GRADUATING A SCALE ON A PLANER.

Editor MACHINERY:

Various devices have been described for graduating a scale; why a machinist should want to make a scale when one can purchase a scale of almost any desired graduation, I don't know, but more for a joke than otherwise the head blacksmith of a shop where I was employed a number of years ago asked me to make him one, and I did so—all on a planer at that.

First, I planed up the blank, leaving it hook-shaped on one end, out of a tool-steel piece 1½ x ½ x 33 inches long; the piece when finished was 1 x 3-16 x 33 inches long. By referring to the cuts, Figs. 1 and 2, an idea of how it was chucked

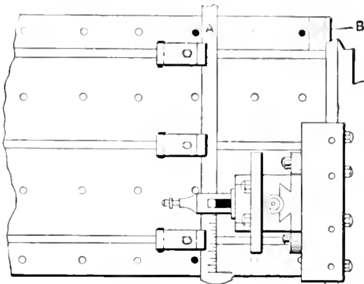


FIG. 1

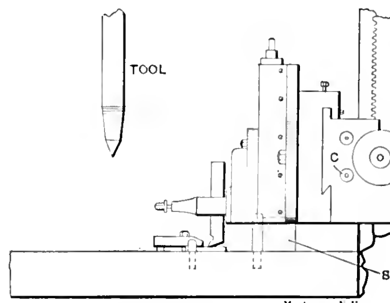


FIG. 2

Graduating a Scale on the Planer.

for the graduating operation may be gained. The feed-screw on the cross-rail was single thread, four to the inch. By scribing a line at *C*, half of it on the rail and half on the feed screw boss, the quarter-inch graduations were easily made; the tool was set to the proper depth, and the feed screw was turned once around for every quarter inch. The planer was pulled by hand until the stop *B* on the platen rested against the rail. By changing the stop the lines cut on the scale were made different lengths, thus giving the inch, halves and quarter lines their proper length.

The inch lines were cut first, afterward starting over again for the half-inch and the same way for the quarter-inch lines. After cutting the graduations for 12 inches, the blank *A* was changed, that is, the tool was moved back to the starting point, and the scale placed under it so the point of the tool meshed in the last line cut; it was then clamped down and another 12 inches cut.

The finished scale was 32 inches long inside the hook, was fairly accurate and is still used by the head smith in that shop to-day. CARROLL ASHLEY.

Rochester, N. Y.

MAKING A BLANKING PUNCH AND DIE.

Editor MACHINERY:

For the benefit of readers of MACHINERY I would like to describe a few features in the making of a blanking punch

and die which diemakers do not run up against very often. As shown in Fig. 2, the die is of the usual follower type, excepting that the perforating dies *a*, *b*, *c* and *d* were to be solid instead of inserted as is usual in this class of work. Six of these dies were made, the only difference between them being in the length of the blank. Fig. 1 gives a good idea of the product.

After the dies were made up they were sent out to a concern that makes a specialty of hardening and tempering only. When the boy brought them back, or what was left of them, the boss's face was a sight to look at. One was broken square across the middle, another was cracked from the corner into the perforating hole, a third had lost all of one corner. The other three dies were all there, but had closed up so badly as

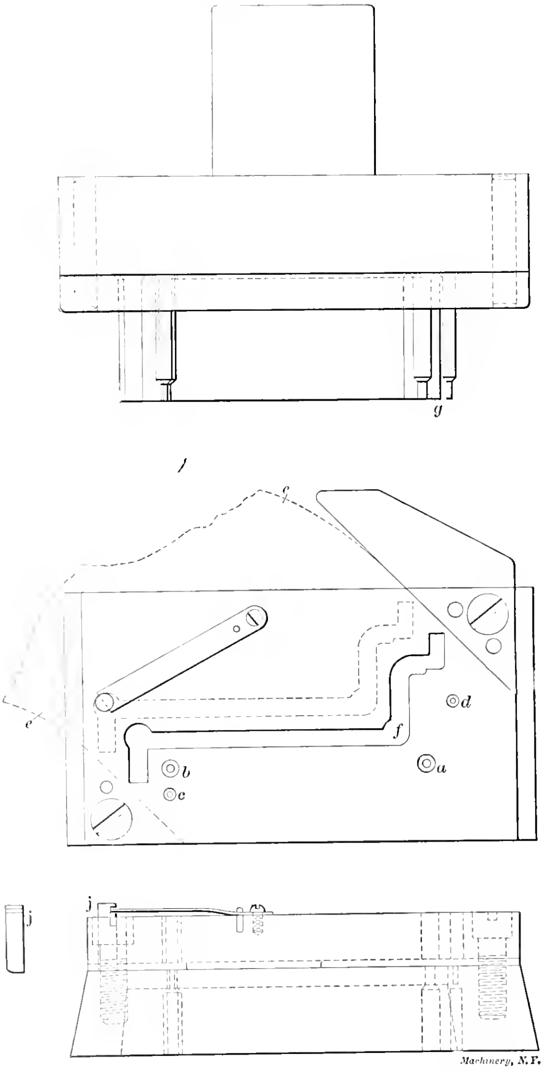


Fig. 2. Punch and Die for Making Blank shown in Fig. 1.

to necessitate annealing and filing over again to a template. After replacing the broken ones and fixing the others, they were given out again for hardening with some warm instructions accompanying them. They came back apparently all right and were set up and tried. When the stock was run through things went well for a stroke or two, but as we punched out more blanks, the waste stock began to assume the shape shown by the dotted lines *e*, *e*, finally jamming so tight under the stripper as to prevent feeding. After measuring up the die again, it was found that hole *a* had spread .0025 inch away from the center of its corresponding location in the blanking die at *f*. As the pilot pins were correctly located in the punch, this caused the stock to feed too far at the right-hand side by .0025 inch at the first stroke, .005 inch at the second, and so on until the waste stock had curved around to such an extent as to stop the feeding. Holes *a* and *b* were also found to be .0015 inch too near together, but this did not interfere with the operation of the machine, since the pilot pins could easily stretch the metal that much.

We tried first to remedy the error by making a new pilot pin, .0025 inch eccentric and putting it in place of pilot, *g*, Fig. 2. This made the hole come that much closer to the edge of the blank, which was quite noticeable, so it would not go. After considering the matter for some time it was decided to anneal the dies and counterbore, as at *h*, Fig. 3; then they were again heated to a cherry red and while in this condition were given an application of cyanide around the cutting edges, and put in the fire again for a few minutes to allow the cyanide to penetrate. The die was quenched as follows: A five-gallon ice cream freezer was produced and packed with salt and ice. The can was filled with sperm oil, and I turned the crank until the oil became thick from the cold. An interval of 20 minutes was allowed between the quenching of each die to let the oil become cold again for the next one. This made the dies hard enough for blanking steel without any further tempering, and without any danger of cracking from hardening twice. After this the die was again ground up.

Fig. 1. Blank to be Made.

A machine steel bushing, .0015 inch eccentric, as shown exaggerated at *h*, Fig. 3, was made to correct the shrinkage of .0015 inch before mentioned. The thick side of this bushing

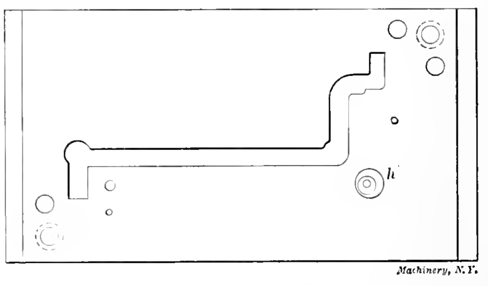


Fig. 3. The Way the Die was Repaired.

was marked and so located in the die as to bring the center distance correct. The perforating die was made next, hardened and ground on the outside by being held .0025 inch off center on a mandrel in an independent chuck. The thick side of this bushing was marked, and then it was adjusted in the machine steel bushing in such a position as to correct the error of .0025 inch referred to, and then driven into place. When again tried, the punch and die worked without any trouble. A stop pin, *j*, is used to locate the stock for each stroke. It is pressed down by the flat spring shown, and has its front edge beveled to allow the stock to slide under it. I am sending you for a sample, the thirty-five thousandth blank punched without grinding the die. H. R. Huber.

Chicago, Ill.

TITLES AND BORDER LINES ON DRAWINGS.

The form of title is often settled by the office, but on the other hand the draftsman may be called upon any time to design a title. To be complete it should include in order of importance:

1. The name of the machine to which it belongs.
2. The shop symbol for the machine, if any.
3. If not an assembly of the whole machine the name, if there is a commonly used one, of the principal parts shown, as:

16-Inch Engine Lathe.
Compound Rest.

4. The words
Assembly,
Assembly Detail,
Details,
according to which it is.
5. Date when finished.
6. Name or initials of designer and draftsman and any other person who is responsible for the drawing. The first four items above must be drawn in heavy type, large enough to be instantly read. The last two will meet all requirements if they are simply legible.

Where parts are numbered or lettered it would be a great convenience if alongside or just over the title, on a detailed drawing, a list of the parts by number which are shown on the sheet were given. While it is quite customary to put on the name of the shop where the drawings are used, it is a form of vanity which is not universal. Unless drawings are being sent out to other shops, or accompanying bids for work, they do not have even an advertising value.

The length of time to be allowed for making the title and border lines depends to my mind on about the same condition that a man's dress does. Border lines correspond to collars and cuffs and title to clothing in general. So we would no more leave a drawing without a title than we would go naked; but on the other hand, for shop use we would hardly dress our drawing up as for a reception. So in the shop I would leave out border lines altogether and put in the title off hand, being certain that it was clear and legible and always in the same corner of the sheet as the drawings lay in the drawer. But if the drawing is going out to help sell a machine, I would have a neat, clear title and a plain, medium border, and put in my best licks on it.

"ENTROPY."

FIXTURE FOR CUTTING SPIRALS ON THE PLAIN MILLING MACHINE.

Editor MACHINERY:

Thinking that it might interest you, I am sending you a photograph of a fixture which I have designed for cutting spirals in one-inch rods, shown in Fig. 1. The fixture itself is shown on a Brown & Sharpe plain milling machine and is driven by the regular feed gearing, as may be seen in the photograph, the telescopic shaft being disconnected from the gear box on the knee and attached to the short shaft at the base of the fixture. From here the motion is transmitted by

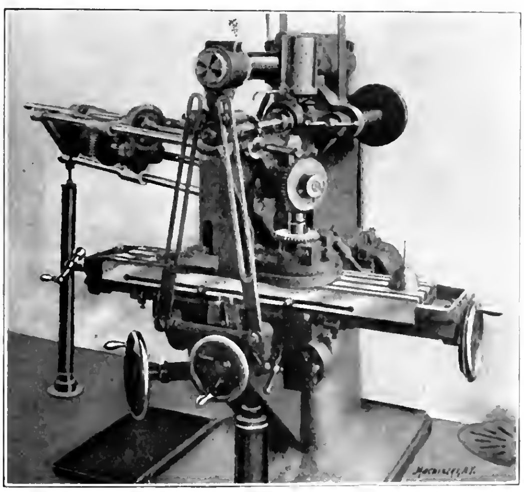


Fig. 1. Spiral Milling Fixture at Work

spur and bevel gears to the rotating gear which revolves the work, and the feed nut which feeds the head and the work forward toward the cutter. This head, which carries the rotating gear in whose hub the work is clamped, slides on the framework of rods seen in the cut extending to the left of the machine. Both right and left-hand spirals are cut by making simple changes in the gearing. At set-screw in the hub of the rotating gear enters a hole drilled in the work, and thus holds it while the cut is taken. When the other end is milled, the set screw seats in the grove already cut, and the milling the second operation removes the set screw hole used for the first. Besides this means of securing the shaft the gear hub is split and may be tightly clamped on the work.

If it is desired to cut larger spirals, the fixture may be extended by using longer distance rods and feed screw.

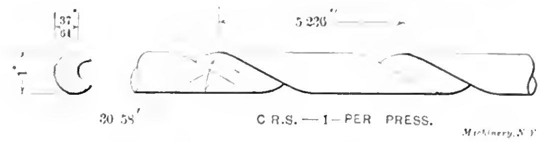


Fig. 2. The Spiral to be Milled.

About eight inches of finished work may be seen extending from the bushing under the cutter. The various bolts for making the adjustments are on the outside of the fixtures within easy reach. The machinists did a good job in making this apparatus, and it has given satisfaction without being changed in any way from the original design.

Pawtucket, R. I. HAMILTON RICE.

THE ADVANTAGE OF PRACTICAL SHOP TRAINING FOR THE DRAFTSMAN.

Editor MACHINERY:

The modern tendency toward specialization has had a deplorable effect on the draftsmen of to-day. There are few shops where the draftsmen, especially those who design tools and fixtures, ever follow up in the shop the drawings they make in the drafting room. This state of affairs, which inevitably leads to friction and misunderstanding, may to a large extent be avoided if the draftsman has had the necessary training to enable him to see clearly the actual performance of all the operations indicated by the drawing. To better illustrate this distinction between the strictly technical and the practical man I enclose a sketch of a jig designed to drill the two holes in a large quantity of the brass lugs shown in Fig. 1. The draftsman's instructions were to devise a method of quickly drilling any one of the different size holes in the same relative location in each end of the lug. The design of the first he drew out would undoubtedly have performed the work well, but before receiving the approval of the chief draftsman, the design was somewhat altered and cut down to the shape shown in Fig 2.

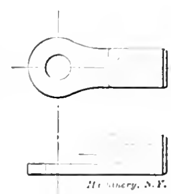


Fig. 1. Lugs to be Drilled in Jig.

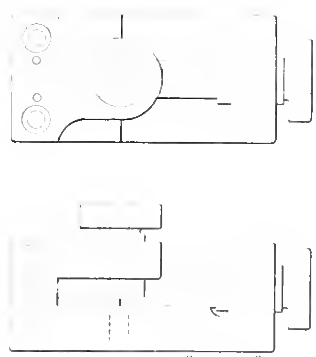


Fig 2. The Draftsman's Jig

During this time there had already been a few calls from the shop for that jig to drill those lugs, and just as the drawings were about finished and ready to go out, there came a hurry call for drilled casting that had to be heeded. At this juncture the foreman, instead of waiting for the completion of the jig, made a false jaw for the milling machine vise

with two V grooves, as shown in Fig. 3, and with the aid of a drill chuck in the milling machine spindle he drilled the entire lot before the toolmaker had fairly started on the jig. It would be an injustice to say that the draftsman was entirely to blame for the delay, still if he had had the foreman's shop experience he would have drilled the rush lot first, and designed the jig later.

Another instance of somewhat different character shows what a variety of talent is sometimes demanded of a draftsman. The large drill grinder used in the shop did more harm than good, because the boys, by overfeeding, drew the temper on every drill they attempted to grind. It was decided to convert it into a wet grinder, but you should have heard the howl that went up when the question of cost of tank, pump, piping and valves came up. Cost almost as much as the grinder itself, said the purchasing agent, as he looked at the elaborate sketch of the converted machine. But the draftsmen, who had by this time "got the hang of the job," evolved an idea which may be considered brilliant, and entitles him to consideration as a sanitary engineer. The water supply to the grinder, in accordance with his plans, was taken through a small galvanized iron pipe from the regular city supply, and the cast iron drip was drained through the floor into an open sink in the loft below, thus providing the grinder with a supply of fresh, clean, cold water, instead of the dirty, gritty substance which is generally used to cool the drill, but which clogs the pores of the emery wheel instead. Where the water supply is cheap and plentiful, the efficiency and low cost of maintenance of this method certainly compares favorably with the valve, pump, and tank system, which somehow is always in need of repairs. In fact, its trial in this shop was so successful that in the course of time all grinders in the shop were equipped in this fashion. In some of the larger shops complete piping systems of this kind are installed to supply lubricant to the cutting tools, to provide a constantly cool hardening bath, and for various other uses which have suggested themselves.

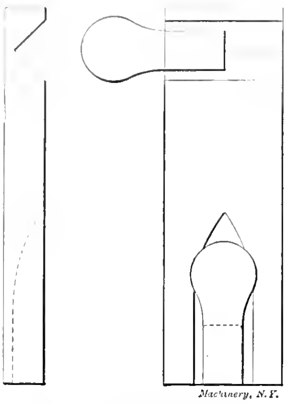


Fig. 3. The False Vise Jaw the Foreman Made.

H. J. BACHMANN.

New York.

AN UNUSUAL METHOD OF MAKING TUBES.

Editor MACHINERY:

The tools and operations described below were for the purpose of producing short tubes of steel that required to be made very accurately and therefore were machined inside and out; their dimensions were, 1½ inch outside diameter, 11-16 inch hole, and 3½ inches long.

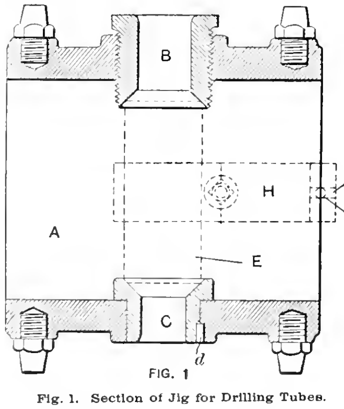


Fig. 1. Section of Jig for Drilling Tubes.

The pieces were first drilled in the jig, Figs. 1 and 2, using a heavy power-feed drill press; then reamed to size, and the outside turned off in a lathe on a special arbor. The drill jig that was used has a cast-iron body, *A*, consisting of a base, top, front and rear walls, but no side walls. Jig legs were provided for the base and the top, and there were bosses to

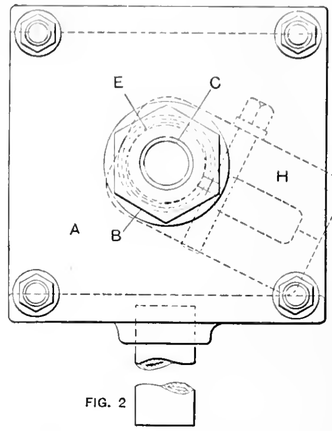


Fig. 2. Plan of Jig for Drilling Tubes.

receive the bushings *B* and *C*. The bushing *C* is driven in and pinned by a tangent pin, *d*, while the bushing *B* is threaded and made hexagonal at the outer end so as to be screwed in by a wrench. The inner ends of both bushings were beveled to an angle of 45 degrees, and served to center the pieces of stock, which before being put into the jig were slightly beveled in a press. The position of a piece of stock ready for drilling is shown at *E* in dotted lines.

To prevent the pieces of stock from turning in the jig while being drilled, clamps *H* were employed, consisting of two jaws *I* and *K* clamped together by a screw *L*, and kept in alignment by a pin *m*, in the jaw *I*, bearing in the groove o in the jaw *K*.

The parts of the jaws that come in contact with the piece of stock *E*, which is represented in the plan view of the clamp by the dotted circle, did not exactly conform thereto, bearing closely at *k* and *k′*, but were relieved at *p*, thus giving a wedging action as the screw *L* was tightened, and holding the stock *E* very securely.

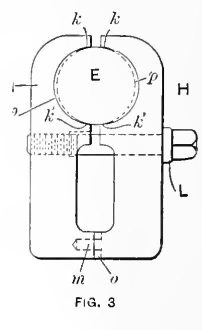


Fig. 3. Clamp for Holding Tubes.

Brooklyn, N. Y. C. D. KING.

PULLEY CROWNING.

Editor MACHINERY:

So far as I have been able to discover, the question of the crowning of pulleys has received very little attention from compilers of data for mechanics. It may be to many as it

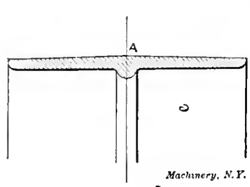


Fig. 1. Pulley with Straight Crown.

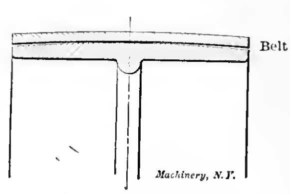


Fig. 2. Pulley with Curved Crown.

was to one mechanical engineer to whom I broached the subject, a matter not requiring any data. However, even he agreed that either of the common forms of crowning had the faults I pointed out; hence this attempt to start a discussion among your readers with the ultimate object, a machinery data sheet.

One form of crowning commonly used consists of two conical surfaces which meet at the center of the pulley face. Of course trouble results from the sharp edge (as shown at *A* in Fig. 1), which tends to crack the belt after long service.

The other common form is the arc of a circle. Now if the arc is of short radius to give the necessary amount of crown, the belt cannot bear across the entire surface, as that would mean an undue elongation of the center of the belt and no stretching of its edges, which we know does not take place. Hence it rides on the high part of the curve and an 8 inch belt becomes in effect a 6-inch (See Fig. 2). And if we make the radius sufficiently long, so that its entire face is in contact with the belt, the amount of crown is not enough for medium or high-speed belts.

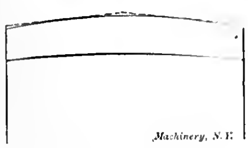
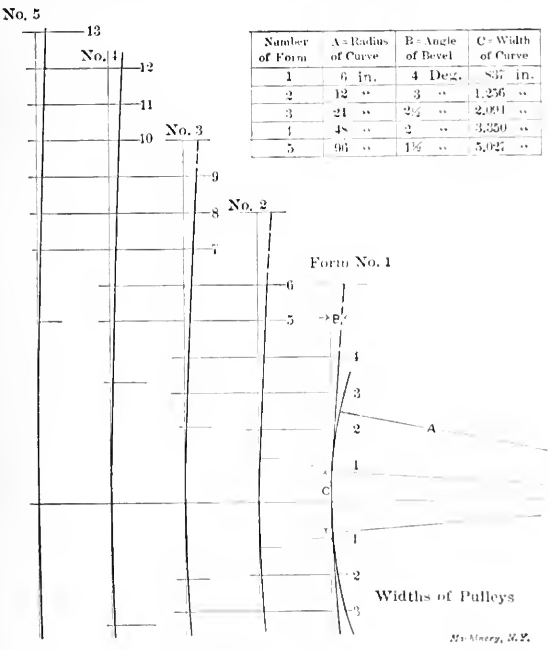


Fig. 3. Proposed Form of Crown.

But now let us combine the two as has been done in Fig. 3. The dotted lines show the two conical surfaces, the upper full line the arc, and the lower the two combined. The arc cuts off the high sharp edge of the two straight faces, and the tangents to the curve relieve that faulty dip at the end of the arc.

What should govern the amount of crown and where shall we place the limits? Kent says, under "Convexity of Pulleys:" "Authorities differ. Morin gives a rise equal to 1/10 of the face, Molesworth 1/24; others from 1/8 to 1/96. Scott A. Smith says the crown should not be over 1/8 inch for a 24-inch face." Interesting but hardly instructive.

Authorities certainly do differ. However, one thing seems to me to be apparent, and that is, that the amount of crown



Number of Form	A = Radius of Curve	B = Angle of Bevel	C = Width of Curve
1	6 in.	4 Deg.	.837 in.
2	12 "	3 "	1.256 "
3	24 "	2½ "	2.091 "
4	48 "	2 "	3.350 "
5	96 "	1½ "	5.027 "

Fig. 4. Diagram giving Dimensions of Proposed Crown for Pulleys

should increase with the belt speed. In the diagrams shown, five combinations have been laid out; for instance, No. 1 was laid out with the radius of the arc 6 inches and the angle of bevel 4 degrees. The center line of the pulley face is the horizontal center line of the figure, and the numbered horizontal lines indicate the widths of the pulleys in inches. The diagram is not extended full length below the center line, as it is the same above this line as below it.

It will be noticed that in most cases each of these lines extends over three of the five different forms, thereby showing three different degrees of crown for each width of pulley, to be used for slow, medium or high speeds, respectively. At present our shop has in use Gisholt turret lathe formers corresponding to Nos. 1, 2, 3 and 4; the dotted lines show how much these formers overlap what is recommended for usual practice. GEO. A. GAUTHIER.

Hartford, Conn.

TWO TOOLHOLDERS AND A DIE MAKER'S SQUARE.

Fig. 1 shows a tool holder for use where the tool is formed on the end of a round bar. It is made of machinery steel and case-hardened. The hole is 3/8 inch in diameter and runs about 3/4 the length of the stock. Its point of advantage over other toolholders lies in the fact that at *C* a slot is sawed clear through centrally and in line with the hole. In use, the

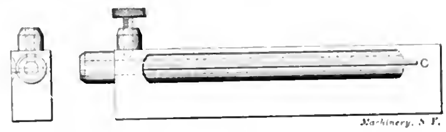


Fig. 1. Holder for Tools having Round Shanks.

tool post setscrew binds the web made by this slot and holds the inserted tool permanently in the desired position. The knurled thumbscrew has little to do, but adds its mite to the before mentioned setscrew, and takes out a "chatter" once in a while.

A very convenient radius tool is shown in Fig. 2. As may be seen from the cut the tools are turned in the lathe to such a diameter as to give the radius desired. The toolholder I

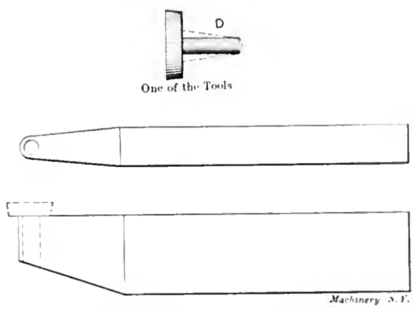


Fig. 2. Radius Tool and Holder.

saw of this design was built to receive tools with a straight shank, but I believe it would be an improvement to make the tools for this holder with a tapered shank or stem, with holes to correspond, as shown by dotted lines at *D*. As the tools are to drive in and are used very much, a straight holder soon becomes a "slip fit."

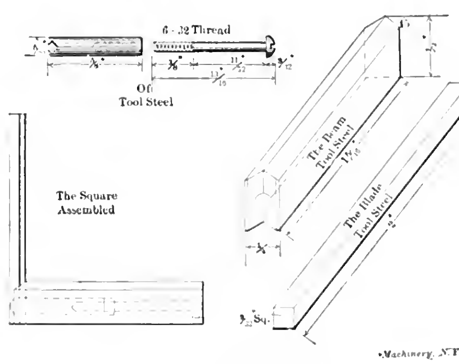


Fig. 3. Die-maker's Square.

Fig. 3 shows the best tool I have ever seen of its kind. It is called a "die maker's square," though it is exceedingly useful to other than die makers since it combines the functions of both the square and the depth gage. The plate and beam are hardened, ground and lapped. The picture will show the construction without any further explanation. I do not know just who devised this tool, but whoever he is he deserves a biography. CARROLL ASHLEY.

Rochester, N. Y.

A DRAWING ROOM INSTRUMENT HOLDER.

Editor MACHINERY:

Almost every draftsman knows how annoying it is, when making drawings where numerous instruments, triangles and other parts of the drawing outfit are used, to have them lying on the drawing board to have them handy. They are "always in the way," to say the least; they obstruct the view of the drawing, get mixed up with the T square or parallel ruler, or, if the drawing board is inclined the right angle for convenient work, they slide off. To overcome the above difficulties I have designed a holder the success of which has led me to describe it for the benefit of other draftsmen.

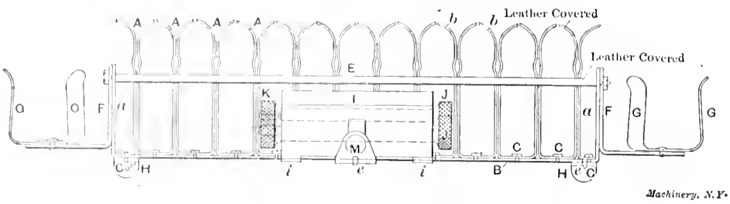


Fig. 1. Front View of Instrument Holder.

The holder is shown in Figs. 1, 2 and 3. Fig. 1 is the front elevation, Fig. 3 the plan, and Fig. 2 an end view. It consists of a series of spring clamps *A*, 12 in this case, which are fastened to a base plate *B* by means of screws *C*. The springs forming the clamps are made of polished spring sheet steel .018 inch thick. The base is made of sheet brass 1/16 inch thick, shaped out and bent at the ends to form the ears *a*. Holes are drilled in the springs large enough to freely admit a 3/16 inch wire rod *D*, Fig. 3; the rod has a thread and nut at each end which holds the ears *a* in place and also serves as a stop for thin tools inserted between the springs, such as triangles or scales. A second rod *E*, which is held by the extension of the ear *a*, also serves to support the ends of the long instruments held in the springs. The springs *A* are covered with thin leather down to and below the rod *D* on their inner surface, as are the rods *D* and *E*, which insures instruments and tools made of celluloid against injury. The tops of the springs are cut away a little over one-half of their width at *b* and on alternate sides so that one spring will not come in contact with the other when opened out; in this way a larger number of springs can be placed in a given space. On both ends of the base *B* and to the end of the case *a* are screwed the angular pieces *F*; they in turn carry on their extreme ends three springs *G*, which securely hold the drawing ink bottle. The angular pieces *F* can be adjusted to suit the inclination of the drawing board. As I use only one ink bottle, I have placed a receptacle in the other ink bottle holder for holding the rubber erasers and pen wiper.

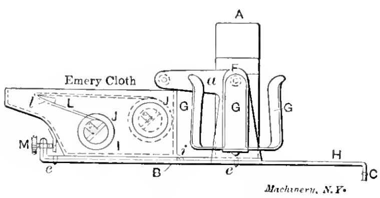


Fig. 2. End View of Instrument Holder.

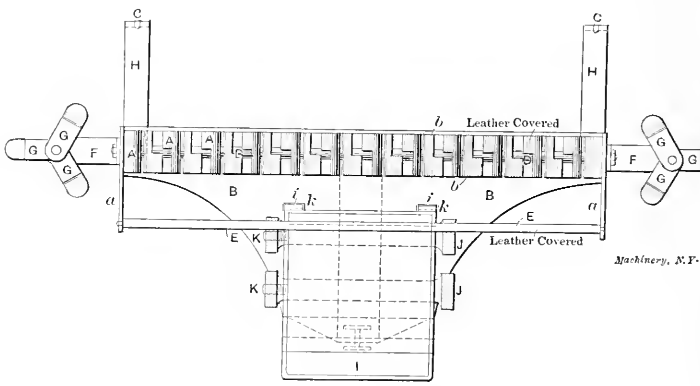


Fig. 3. Plan of Instrument Holder.

Two narrow strips *H* are soldered to the bottom of base *B* and bend down at the end to hook over the top edge of the drawing board; and with the two needle points *c c* in *H* and the three in the base *B* at *e e e* the holder is securely fastened, but can be picked up and located in another place if necessary. *I* is a lead sharpener, and is contained in a box made of sheet brass 1/16 inch thick. The spindles *J* pass through the box and are locked by means of the shoulder *f*, Fig. 4, being drawn against the inner sides of the box by the nut *K*. Emery cloth is inserted in the slot *g* in the spindle and held by the headless screws *h*, Fig. 4. The emery cloth is drawn over a knife edge shaped piece *L*, which produces a very sharp edge (see dotted lines in Fig. 3), thereby enabling the lead to be sharpened in compasses that are almost closed by rubbing on the under surface at *l*. A new surface is produced by loosening both spindles and winding enough on one to present an unused part of the emery cloth, and then locking it; the emery cloth is then stretched out with the other spindle, which is also locked. I find that No. 90 emery cloth answers very well. To cleanse and remove the emery cloth, the box may be detached by loosening the screw *M* and lifting the two lips *i* out of the slots *k* in the base *B*.

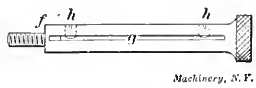


Fig. 4. Spindle for Holding Emery Cloth.

CHAS. P. THIEL.

Lawrence, Mass.

* * *

The idea that every employe pays for superintendence has been expressed time and time again in various ways, but it is one that every man should thoroughly understand. The boy or man whose every effort must be directed by a boss must expect to receive the lowest rate of compensation. As he becomes more proficient and learns to do his work without ceaseless superintendence he becomes more valuable and his salary should increase in proportion as the need for superintendence decreases. When he acquires such proficiency that he is not only able to direct his own work but that of others, his compensation is not generally fixed by the law of competition so much as it is by the profits of the business in which he is engaged.

* * *

IN a discussion which has been in progress in the columns of the *New York Times* over the expression, "the tempering of copper," Mr. Arthur Jones Hopkins, of the Department of Chemistry, Amherst College, has contributed an explanation of the term which would tend to remove some of the mystery that has always surrounded the process. He says that the idea that the ancients were able to harden copper, arises from the thirteenth century misapprehension of the Greek word *baphé*—a word used by the Græco-Egyptian alchemistic writers of the third century. Berthelot, the eminent authority on alchemy, has shown that this word may mean tempering, coloring (of cloth, glass, and metals), the coloring materials, or the coloring bath. Egyptian alchemy was busied originally in producing brilliant bronzes on copper and the copper alloys; and this expression "the tempering of copper" means, and always has meant, bronzing copper so that it may stimulate silver or gold.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

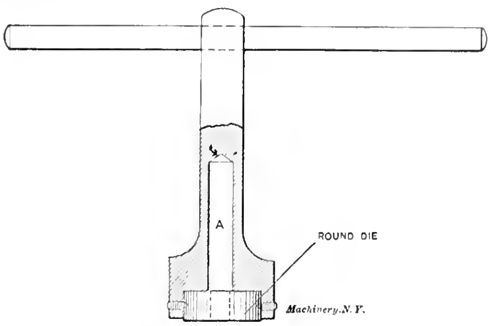
HOLLOW GRINDING CENTER REAMERS.

In order to make a center reamer of the plain style, easy cutting, use a 4-inch emery wheel to hollow-grind the flat face; by so doing the reamer will not only cut easier but will keep its edge longer. HARRY ASH.

Chicago, Ill.

A DIE SOCKET.

The cut shows a die socket which is a handy tool to have around; it can be used for running over the threads of U-bolts



or studs in place. The shank is drilled 4 or 5 inches to allow passage for the end of the bolt, as shown at *A*.

Schenectady, N. Y. R. B. CASEY.

A TOOL SUPPORT FOR CUTTING DEEP KEYWAYS.

Most of us are no doubt on "speaking terms" with the style of key-seating tool shown in Fig. 1 for use in planer or shaper. Some of us use it with cutting edge pointed downward; others point the cutting edge up. I prefer the latter method as the tool cannot spring away and the drag on the back stroke does not do harm enough to speak of. Sometimes it is necessary to

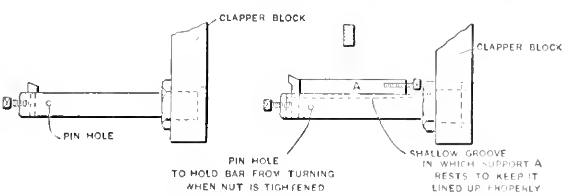


FIG. 1 FIG. 2

cut quite a deep slot or key-seat in order to avoid shifting the tool after it is once set. I merely set it out the amount necessary and use a support in the back as shown in Fig. 2. It works finely and quite a good bite can be taken at each stroke of the ram without danger of breaking off the tool as might be the case without the support. In cutting steel plenty of lard oil should be used. R. A. LACHMANN.

Chicago, Ill.

PREVENTING THE LEAD FROM SLIPPING IN THE PENCIL HOLDER.

Editor MACHINERY:

I have enjoyed reading from time to time, the articles in your paper that are of interest to draftsmen. I am led to present what I consider a valuable little kink which I accidently discovered one day.

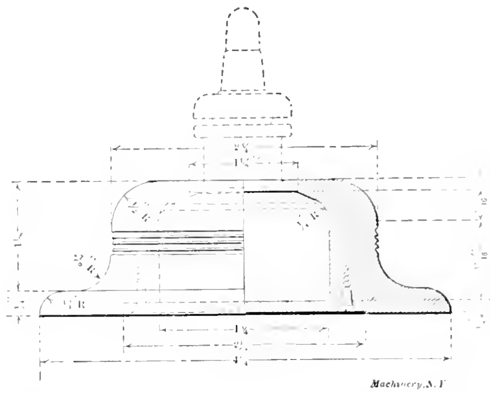
It is in connection with the artists' movable lead pencil holder. Every draftsman has had more or less trouble in trying to prevent the lead from slipping back into the holder after the chuck jaws have become a little worn from use. To overcome this the usual method is to screw the chuck sleeve tight until the threads are stripped or the clutch is loosened in the holder. Many good holders are short lived on this account, and this has prejudiced some draftsmen against the use of them. My method of preventing this trouble is as follows: I remove the chuck sleeve and lead, hold the pencil holder by the chuck jaws with thumb and finger, and with a small flat headed hammer, give the end of the jaws a succession of light rapid blows. This causes a burr edge to form on the inside of the jaws. Upon replacing lead and sleeve and tightening up with ordinary pressure, it is easily seen that the small edge on the jaws grips the lead firmly, making it impossible to force the lead back even when considerable pressure is brought to bear upon it.

I find that this simple method preserves the pencil for an indefinite length of time. S. J. B.

AN INK BOTTLE HOLDER.

Editor MACHINERY:

It's no use crying over spilled ink; just clean it up and then before you spill any more, get an ink bottle that will hold. Here is one made for a Higgin's drawing ink bottle that not only holds but is cheap, easy to make, light, neat, and will not tip over easily. Its construction does away with toothpick wedges and strips of paper to keep the bottle tight. The round piece fitted in the bottom is held with



four No. 4 wood screws ½ inch long. If the bottle does not fit tightly put a piece of card underneath. Any patternmaker can turn one out in a short time, and with a coat of shellac it makes a very presentable appearance. The straight, grooved sides make it easy and safe to handle. Three or four ¼-inch holes in bottom with old lead pencil rubbers forced in will make it non-slipping. D. C. TURNBULL.

Mishawaka, Ind.

POLISHING UNFINISHED SURFACES.

When polishing either cylindrical or flat parts which do not show up to good advantage owing to their not having a nice smooth finish (as, for instance, cold drawn stock which has not been turned or machined at all) a much better effect can be obtained if they are given a dull finish by criss-cross polishing. If the piece is round and can be run in the lathe, move the emery cloth back and forth while the work revolves and a nice effect will be the result. As to flat surfaces, I merely rub the emery cloth over them in all directions and this produces a very satisfactory appearance. R. A. LACHMANN.

Chicago, Ill.

TO HARDEN TOOLS WITHOUT DANGER FROM FIRE-CRACKS.

In hardening and tempering cutters, dies, punches, etc., where there is danger of breaking or cracking, many dollars may be lost or saved, according to the manner in which it is done. The following is a method I have used for all cases whether the work be small cutters or large and expensive dies. First cover the cutting edge of the cutter or the design on the face of the die with a thick coating of paste made from ground bonedust and crude oil. Heat the work slowly until it comes to a cherry red. Use charcoal, and bank the fire completely over the work. When it has been well heated, cool immediately until the work can be taken hold of with the

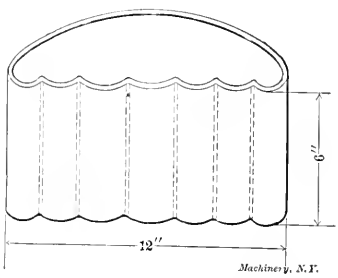
bare hand, then shut off the blast from the fire and again heat the tool until sawdust thrown upon it will burn. The work must be got into the fire as soon as possible after the first heating to prevent checking or cracking of the steel. The die or cutter can then be polished and the temper drawn without any danger.

With tools or cutters where it would injure the cutting edge or where the tool is so small that it cannot be polished for drawing the temper, the color may be observed by pursuing the following course: When the tool is first put into the fire and becomes hot enough to melt ordinary soap, rub soap generously over the face of the cutter. The potash in the soap will eat the dirt and grease from the metal and cause it to be perfectly white after it is cold. The temper may then be drawn in the usual way. JAMES F. COYNE.

East Providence, R. I.

A POCKET INSTRUMENT CASE.

It is notorious that few draftsmen have cases for their instruments. In fact, it has been said, that the difference between a fully qualified draftsman and an amateur is that the former keeps his tools in a cigar box. For carrying instruments about with one I have seen nothing so handy as the wallet, shown below. It is made of a single piece of chamois



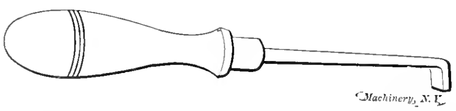
leather folded up to form a large pocket, which is then subdivided, by stitching, into separate compartments for different instruments. The cover folds over and the wallet is rolled up and tied with tapes attached to one end. It is then a handy size for slipping into the pocket. H. L. MILLER.

Manchester, England.

* * *

METHOD OF MARKING NEGATIVES.

It may be of interest to call attention to the method of marking negatives devised by Mr. H. E. Erwin and used in the drafting room of the New Britain Machine Company. We use a small scraping tool, like sketch below, to remove the film from the dried negative; this being done in any convenient place where the loss of detail will not be noticed. Over such a prepared spot is gummed a black rectangular slip from which the number of the negative has been punched by the office check punch. (Samples of these slips are enclosed herewith.) It is a very slight job to scrape the gelatine from the negative, and if the edges of the scraped portion are not absolutely perfect, it makes no difference, because the gummed slip covers them.



In the prints, the number of the negative then appears in dark letters on a light background, and the contrast between the two is as strong as the deepest tone and the highest light can give. The number, of course, serves to identify either the negative or print, and directs the proper filing of the former, in numbered envelope.

* * *

We have always supposed that the man who sat on the wrong side of the saw when he cut the limb off the tree was a mythical character, but according to a recent news item he is a living—or better, half-dead Italian. He lives in Bloomfield, New Jersey, and was sent up a tree by his employer to remove a limb which would interfere with a new building which was being erected. It was thirty feet to the ground and the Italian was seriously hurt.

* * *

Automatic machinery which performs some difficult operation is not usually so designed as to duplicate the manual action of the human operator, although the same result may be performed. The difficulty of handling the parts which form a product generally causes same to be modified in some way so as to be simply handled by the mechanism. A case in point is the shoe-pegging machine which makes its own pegs from wooden strips as the pegging proceeds; in this way the difficulty of handling small pegs and presenting them point foremost to the work is avoided. A similar operation of much greater delicacy is a riveting machine used, in making watch movements, for riveting the hook on the end of the mainspring. The handling of the minute rivets required would be, perhaps, an almost impossible accomplishment for any automatic machine; at any rate it is unnecessary. The way the difficulty is avoided is to punch the holes through both the hook and the mainspring simultaneously and to punch the rivets from stock supplied for the purpose. The next motion of the machine inserts the rivets punched out and heads them over. This process is an example of how the designer of machinery must adapt himself to the character of the product for which the machine is designed, and incidentally to take advantage of its cost. Now it is obvious that a machine for riveting boilers automatically could scarcely be expected to be efficient or economical in operation if the rivets were punched from stock the same as in the mainspring-riveting machine; aside from the cost the quality of the rivets would be very inferior. But the practice is admissible and desirable in the assembly of small mechanisms. In short, the designer of light automatic machinery generally has a license in the manipulation of the stock which is not allowable in the work of ordinary dimensions.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

Editor MACHINERY:

I offer the following as an answer to question No. 57, O. G., in the "How and Why" department of the August issue of MACHINERY.

As there are a good many different kinds of high-speed steel on the market, and as these various kinds differ widely as to composition, it would have been possible to have given a more definite answer to the question had the latter contained information regarding what kind of high-speed steel the questioner had special reference to. However, there is one acid that will dissolve almost any kind of high-speed steel—most likely all kinds. This acid is composed of nitric acid (HNO_3) and hydrochloric (muriatic) acid ($H\,Cl$) in the proportions of one to two ($HNO_3 + 2\,H\,Cl$). This acid is known as nitro-muriatic acid, or aqua-rigis, and can be procured at any drug store. The writer has used this acid on several kinds of high-speed steel, and always with success. There is, of course, no question but that other acids can be used for different kinds of high-speed steel, and one would not have to be much of a chemist to find what acid or mixture of acids to use for etching such kinds of steel, if only the composition of the steel be known. For example, the writer happens to know the composition of Novo high-speed steel (probably the most used European high-speed steel on the American market) and as common etching acid had no effect on same, and the acid mentioned above at that time was not known to me, I used sulphuric acid ($H_2\,O_2\,SO_2$) mixed with water in about equal proportions. A slight amount of nitric acid was added to the above and gave still better results, although the steel could be etched without it. The reason for using sulphuric acid on this particular steel is very obvious to a chemist after he knows of what the steel is composed. A. A.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

STURTEVANT ENGINE AND GENERATOR.

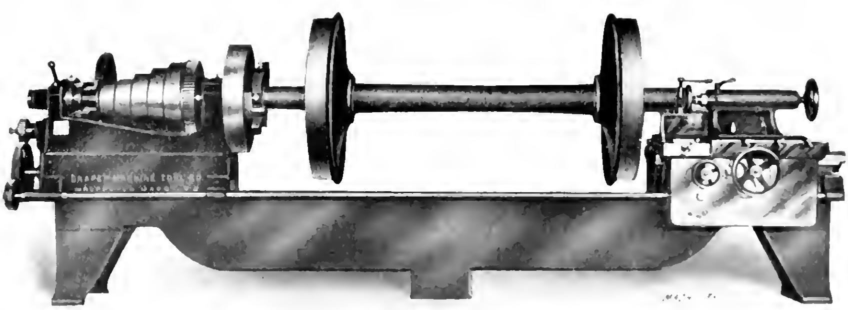
The B. F. Sturtevant Co. of Boston, Mass., have just completed the design of a line of direct connected generating sets, of which we show an example in the accompanying cut. As may be seen, it is exceptionally pleasing in its general lines and proportions. The engine illustrated is of the single vertical enclosed automatic type with cylinders 9 inches in diameter by 8 inches stroke. It is fitted with a balanced piston valve, is thoroughly insulated with magnesia and covered with Russia iron bound with polished iron bands. The regulation is accomplished by means of a Rites' fly wheel inertia governor, which is simple in construction and holds the speed variation within a limit of 2 per cent between full load and no load.

Sturtevant Generator Set.

The generator was specifically designed by the manufacturers for direct attachment to its respective size of engine. The armature is of the barrel wound, toothed hollow drum type, the windings being of the coil or bar wound type. The field frame of the generator is of cast iron with wrought iron pole pieces and cast iron shoes. In the construction of the commutator the best drop forged copper is used, thoroughly insulated by selected amber mica. Soft carbon brushes are employed. The heat rise of the generator will not exceed 40° C. for a four-hour full-rated load run. An overload of 25 per cent can easily be carried for two hours. The complete set of the size illustrated weighs 4,900 pounds.

GAP LATHE FOR RAILWAY SHOPS.

The illustration shows a 22" gap lathe, especially adapted to steam and street railway service for truing car axles when the car wheels are in place, thus saving the time of forcing the wheels off, truing the axles, and then forcing them on again as is usually done. This lathe swings 22 inches over the ways, and will take a standard car axle with wheels in place over the gap. It has a 13-foot bed which takes 7 feet 8 inches between centers, and is furnished with a rod feed and plain block rest as shown.

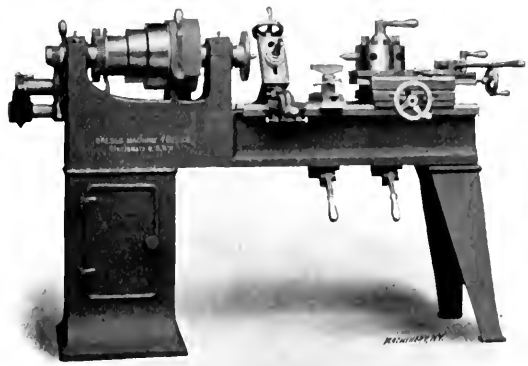


Gap Lathe for Railway Shops

This lathe can also be furnished with a block to fill the gap, compound rest, leadscrew, and gears for screw-cutting, so that it can be used as a regular engine lathe when not being used for truing axles. It is made by the Draper Machine Tool Co., Worcester, Mass.

FIFTEEN-INCH FRICTION BACK GEARED MONITOR LATHE.

The accompanying engraving shows a turret lathe which is built by the Dreses Machine Tool Co., Cincinnati, Ohio. The bed is of the V top pattern and is seated on a three point bearing to prevent the possibility of springing and getting out of alignment through careless setting up or through the settling of floors and foundations. The tail leg is attached to the bed with a hinge and can be fixed to the bed by simply tightening a nut.



Back-geared Monitor Lathe.

The head stock is cast solid with the bed to insure strength and rigidity, and is provided with either phosphor bronze or babbitt metal bearings. The friction clutch back gear is simple and positive and enables the operator to use two speeds without stopping the machine. The wear is taken up by a screw driver from the outside. The spindle is made of a specially hammered crucible steel with an 1⅝-inch hole through it.

The turret is bored to receive six tools and revolves on a ground steel stem and is provided with an adjustment for taking up the wear. The index ring is of hardened steel, nearly the diameter of the turret, with ground notches for the locking key, which is withdrawn by the return stroke of the turret slide. The wear in the seat for this locking key

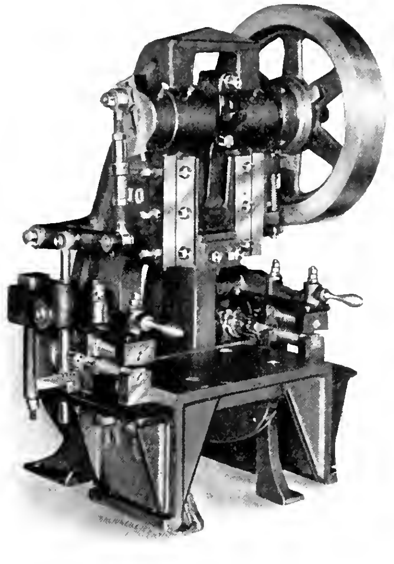
is taken up by a taper gib and differential screw. The slide is provided with both screw and lever feed. It moves in a square bearing with a taper gib the full length of the slide, for taking up the wear. The swivel slides are graduated and provided with an easily accessible clamping device. It has also a screw cross feed with graduated collar.

The machine is provided with a chasing bar which slides in three bearings on the rear of the bed. This chasing attachment will cut right and left-hand, straight and taper threads with the same nut and follower. The taper attachment is adjustable and graduated and is of such construction that the follower is not withdrawn from the nut when cutting taper threads. Nuts and followers for cutting 11½, 14 and 18 threads, and a double friction countershaft accompany every machine.

BLISS PRESS WITH SPECIAL DOUBLE ROLL FEED.

In the accompanying half-tone we illustrate a compact machine with a special automatic double roll feed, designed for cutting the teeth on band saws. The feed is adjustable and will cut either a coarse or a fine tooth from 16 points to the inch to 4 to the inch, common teeth.

An important feature of the press is the construction of the feed rolls, which are open at the end, allowing easy in-



Press Arranged for Notching Band Saws.

sertion and removal of the stock. The two small hand levers shown are used for raising the rolls prior to starting a new strip of stock or for removing an old one. The feed will permit a wide range of adjustment, which is effected by sliding the connection block up or down the "T" slot in the crank on end of the main shaft. This sliding movement is controlled by an adjusting screw which easily moves it to the desired location. The press has a one inch stroke with an adjustment of one inch. The distance from bed to slide when stroke is down and the adjustment up is 7½ inches. The fly wheel weighs 115 pounds and is run at 300 revolutions per minute.

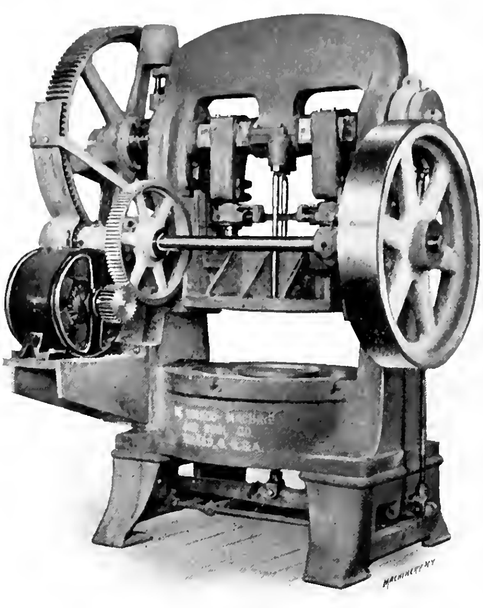
This press was built by the E. W. Bliss Co., No. 5 Adams Street, Brooklyn, N. Y.

DOUBLE PITMAN POWER PRESS.

The machine which we show in the cut is one of a line of thirteen sizes designed and built by the Toledo Machine and Tool Company, Toledo, Ohio, for blanking and perforating disks and segments for electrical work in the manufacture of dynamos and motors. The machine is fitted with a positive knock-out for both the slide and the bed, that on the slide being operated by the two adjustable rods seen projecting from the cap of the middle crank bearing. The lower knock-out is operated from the lever and vertical rod, shown on the right of the brace, by means of a cam on the crankshaft.

The machine, as shown, is direct-connected to an electric motor in such a way that the combination takes no more floor space than is required by the usual belt-driven machine.

The bed of the press is bored centrally with the slide down far enough to form a wide, substantial shoulder in the press

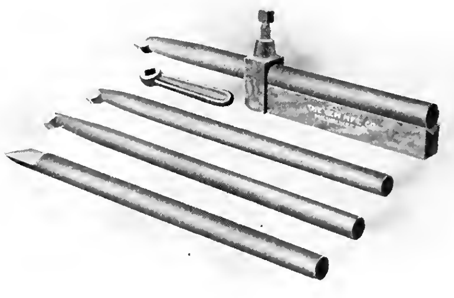


Toledo Blanking and Perforating Press.

bed. This is designed for fitting in the press bed, filler rings which are recessed to receive the dies, in this manner acting as a substantial guide for holding the dies rigidly in position.

GEM BORING TOOL HOLDER.

The halftone shows quite clearly the construction of this tool holder, which is designed to hold boring tools whose cutting edge is formed on the end of a round bar of stock. The principal advantages claimed for the use of this style of holder are: the fact that the boring tool needs to be extended only to the proper length to suit the work, thus avoiding



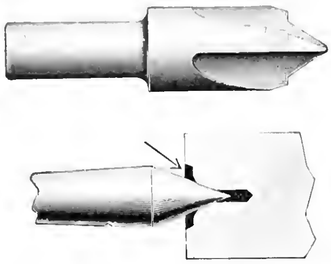
Gem Boring Tool Holder.

unnecessary limberness; its ability to hold boring tools of different sizes; and the firmness with which the tool is held, inasmuch as not only is it held by the clamp screw shown in the cut, but this is supplemented as well by the pressure of the setscrew in the toolpost of the lathe in which the tool is used. The Gem Manufacturing Company, Milwaukee, Wis., are the makers.

AN IMPROVED CENTER REAMER.

The G. R. Lang Company, Cincinnati, Ohio, are making a center reamer which makes a center possessing distinct advantages over the usual style. As may be seen in the cut, the reamer is formed with a shoulder. In centering the work,

which is preferably done in one of the various two-spindled machines, the stock is first drilled with a small hole to form the clearance for the center. The center reamer is then brought into the work until the shoulder is cut well down below the rough stock at the end of the bar. As shown in the lower cut, this has the effect of making it much easier to square up

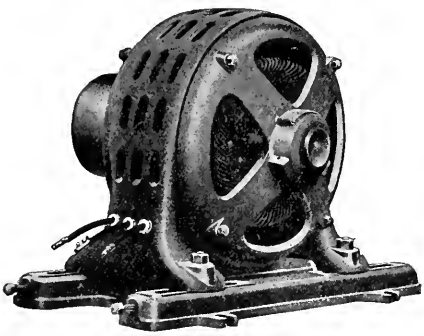


Improved Center Cutter Reamer.

the stock than it would be if the 60-degree countersink ran clear out to the surface. It also protects the center hole from injury, and makes it unnecessary to recenter the work after the rough end has been squared up, as is often the case with the regular center.

INDUCTION MOTORS FOR CONSTANT SPEED.

The Commercial Electric Co., Indianapolis, Ind., hitherto known as makers of direct-current machinery, are now putting on the market a line of constant-speed induction motors. In making this departure they have endeavored to avoid the necessity for passing through a costly experimental stage, by retaining the services of experienced and competent engineers, who are familiar with the most approved practice in this country and in Europe. As shown in the cut, means have been provided to assure thorough ventilation of both rotor and stator, or armature and field as they are termed in direct-

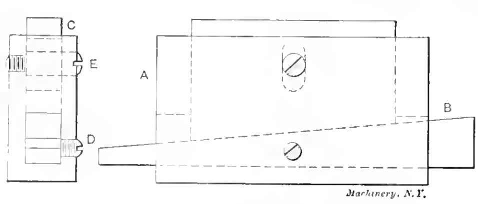


Constant Speed Induction Motor.

current nomenclature. The mechanical construction is such that a small air gap is obtained, evenly distributed around the rotor. The bearings, which are self-oiling and self-aligning, may be inverted when necessary, and are so designed that no injury will result to the machine from accidental flooding. The shafts are of crucible steel, ground to size. These motors are made in all standard sizes, voltages, and frequencies, and in both two and three phases, in 25 and 60 cycles (3,000 and 7,200 alternations).

ADJUSTABLE PARALLEL.

An adjustable parallel is a convenient device for setting planer tools, blocking up work on the milling machine, shaper,



Adjustable Parallel.

etc., or for use on the layout table. We show herewith a tool of this kind which consists of a body *A*, slotted out near the bottom to receive the wedge *B*, and slotted down from the top to receive the follower *C*, whose upper face forms the adjustable parallel surface. This face may be adjusted vertically within a range of ¼ inch. *D* is a setscrew for securing the wedge in the proper position, and screw *E*, passing loosely through the slot in the follower, keeps it from falling out. The operation of the tool is obvious. This device is made of soft steel, hardened steel, or steel hardened and accurately ground, and is sold by the Co-operative Specialty Co., of Buffalo, N. Y.

NO. 2½ "BULL DOG" WRENCH.

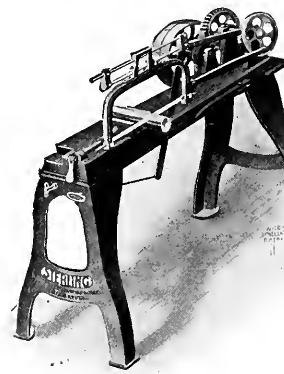
The Whitman & Barnes Mfg. Co. having factories at Chicago, Ill., Akron, Ohio, and St. Catharines, Ont., have recently added to their line and are placing on the market their No. 2½ "Bull-Dog Wrench." This Wrench has a length of 12½

"Bull Dog" Wrench.

inches, holds pipe from ⅜ inch to 1 inch in diameter, and round iron from ⅝ inch to 1¼ inch in diameter. It is drop forged from special steel which the manufacturers have made to their own analysis. It is finished in black with polished jaws.

THE STERLING POWER HACK SAW.

This machine, as shown in the half-tone below, is gear driven, thus providing ample power for the saw from a narrow, high-speed belt. Instead of the usual clutch, a tight and loose pulley is used for starting and stopping the machine, in connection with an automatic shut off which throws the belt onto the loose pulley on the backward stroke of the saw, as



The Sterling Power Hack Saw.

soon as it has cut through the stock. This is a safe and positive arrangement, preventing the possibility of accidental starting of the machine, and consequent breaking of the saw blade. A gravity feed is provided, adjustable for different materials and sizes of stock. This power hack saw is made by the Diamond Saw and Stamping Works, Buffalo, N. Y.

* * *

FRESH FROM THE PRESS.

PRACTICAL PERSPECTIVE, by Frank Richards and Fred H. Colvin. 59 pages 5½ x 8 inches, bound in limp cloth, and illustrated with 62 figures. Published by Derry-Collard Co., 256 Broadway, New York. Price, including two pads of isometric perspective paper, $1.

Every one who has any appreciation of the art of illustration knows that a perspective view of almost any object is much more easily understood than the conventional three-view diagrams almost universally used in drafting room practice. But the supposed difficulty of making perspective drawings usually prohibits its use in mechanical drawing, notwithstanding the advantages that might accrue from its use. The principles of isometric perspective are very easily mastered, however, and the fact that the dimensions on isometric drawing are true to scale makes this system well adapted to the needs of mechanical work. In the first part of the book in review, Mr. Richards explains the principles governing isometric drawing, in a very clear, comprehensive way, and Mr. Colvin follows with a practical explanation of the use of the Derry-Collard isometric paper, which, with a little practice, makes isometric drawing free-hand an easily accomplished task. This isometric sketching paper is ruled with faint blue lines at right angles, forming 3-16-inch squares; crossing these squares oppositely are diagonal lines making an angle of 30 degrees with the horizontal. The two sets of lines thus form a combination of squares and "diamonds," the latter having included angles of 60 and 120 degrees.

previous numbers, not bound.

VARIABLE SPEED MECHANISMS.—5.

RATCHET DEVICES.

The most common variable speed mechanism used on machine tools, aside from the familiar step cone pulleys, is the feed motion, generally employed on planers, slotters and shapers, which utilizes some form of the familiar pawl and ratchet. By varying the throw of the pawl the amount of angular motion is varied and, of course, the velocity, although such devices are not usually regarded as speed variators in the sense here employed. The principle, however, has been more or

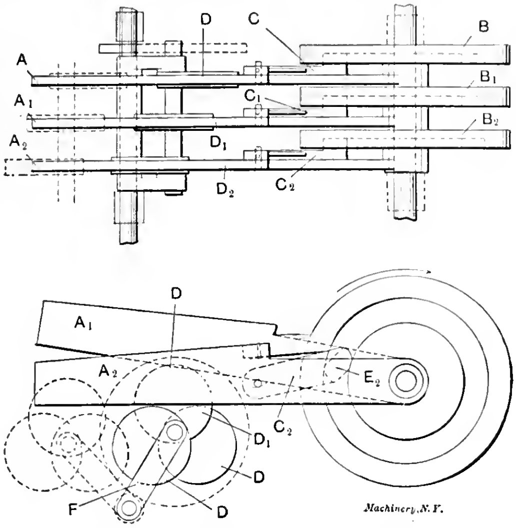


Fig. 48. Patent No. 297,143, granted to W. F. Marks, April 22, 1884.

less successfully utilized in speed varying mechanisms by providing a multiplicity of ratchets and pawls, so that a continued action is maintained instead of an intermittent action as is the case with only one pawl and ratchet.

Fig. 48 shows two drawings accompanying patent specification No. 297,143, granted to W. F. Marks, April 22, 1884, for a variable speed device based on the ratchet principle. It includes the three levers, $A\ A_1\ A_2$, which operate the grooved disks, $B\ B_1\ B_2$ by means of clutches. The clutches are fastened to the sides of the levers and are in the form of three pawls, $C\ C_1\ C_2$, which have projecting lugs of the shape shown

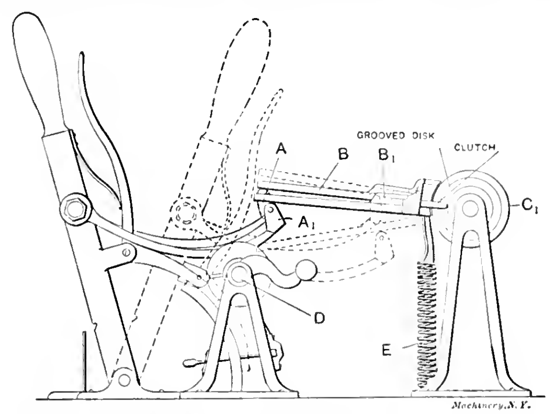


Fig. 49. G. H. Preston's Device for Changing Speed. Patented June 17, 1884. No. 300,734.

in the outline, E_2, in the lower view. These lugs engage the side of the grooves in the disk when the levers are lifted, and thus impart motion; but on the downward movement the gripping action is released, the same as with an ordinary pawl and tooth ratchet. In short, the inventor has provided a friction ratchet whereby he gains the advantage of having an infinite number of teeth and is thus enabled to provide increments of any degree. The levers are operated by eccentrics, $D\ D_1\ D_2$, mounted on a shaft which is in turn mounted on swinging arms so that the position of the eccentrics relative to the levers may be changed at will. It is obvious that when the eccentrics are in the position shown by the full lines in the upper view, the levers are given a greater angular movement than when in the position indicated by the dotted lines. Hence, the variation in speed is obtained by swinging F within the limits indicated.

Patent No. 361,530 was granted to A. J. Martin, June 7, 1887, for the changeable speed gearing illustrated in Fig. 50. This device employs two crank wheels, $A\ A_1$, having cranks of variable throw, each crank pin being connected to a rack which meshes with a pinion at the center of the crank disk. The connecting-rods, $B\ B_1$, are attached to sliding cross heads which communicate the reciprocating motion to the toggle-joint arms, $C\ C_1$. The inner ends of each set of toggle-arms are pivoted on the center of the grooved disk, $D\ D_1$, and engaging these disks are clutches attached to the arms by which motion is imparted to the disks. These clutches grip the sides of the groove with one direction of motion of the crank wheel, as for example in a clockwise direction, and release in the opposite direction. Suppose that the direction of motion of the upper arm, c_1, is in the same direction as the crank wheel and that its clutch engages the groove in disk D_1: It follows that the disk D will have circular motion imparted to it in the direction of the arrow. When the crank reaches the end

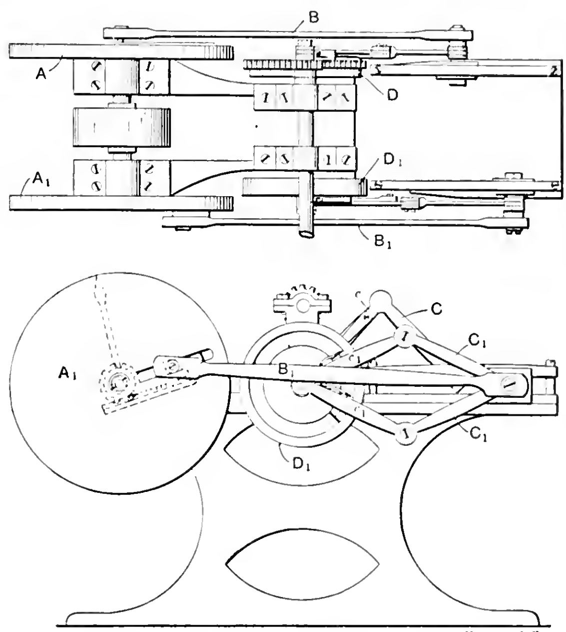


Fig. 50. Changeable Speed Gearing. Patented by A. J. Martin, June 7, 1887. No. 364,530.

of the stroke, the lower arm, c_1, comes into action and the clutch of the upper arm, c_1, releases. A similar action takes place on the opposite side of the machine, from which it follows that the clutches do not drive their respective disks throughout an arc of 180 degrees, but rather through about 90 degrees, thus equalizing the velocity and imparting a fairly uniform angular velocity.

A similar invention to that of patent No. 297,143 is indicated in Fig. 49, accompanying patent specification No. 300,734, which was granted to G. H. Preston, June 17, 1884. This is a device for changing the speed of the feed mechanism of grain drills. The principal novelty of this device, as compared with that of 297,143, is in the construction of the clutch mechanism, and that cams are used in place of eccentrics. The cams have a harmonic motion for a little more than one-half their circumference and this feature permits a fairly uniform movement to be obtained with only two ratchet mechanisms instead of three as in No. 297,143. Referring to the cut, Fig. 49, D is the cam shaft on which rest the rocking levers, $A\ A_1$. The rotation of the cam shaft imparts motion to the clutch levers, $B\ B_1$, which actuate the grooved disks, one of which is shown at C_1. With the levers in the position shown by the full lines, the angular movement imparted to the disks

per revolution of the cam shaft is the minimum; and the maximum angular displacement is obtained when the levers are in the position indicated by the dotted lines. The springs shown at E keep the clutch levers and the cam levers in close

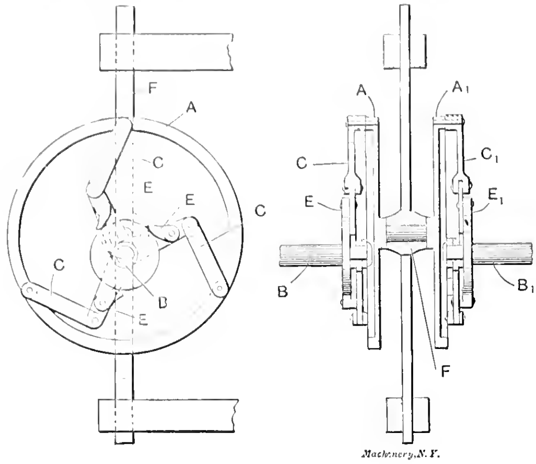


Fig. 51. Patent No. 634,327, granted to L. M. Dieterich, October 3, 1899.

contact with the cams at all points of rotation. The pawl of the friction clutch is a hook-shaped member which spans the rim of the grooved disk, gripping it on the upward movement and releasing it on the downward movement.

November 21, 1899, for a variable speed gear, lies in the method employed for speed control. Referring to Fig. 53, there are two eccentrics, both of which are of the compound type, as shown in the upper view at $D_1 E_1$; that is, each is composed of two eccentrics, one mounted upon the other and both supported by shaft F. In the position shown the compound eccentric has its maximum throw, but shifting D_1 180 degrees so transforms the eccentric that it has no throw; hence no motion will be transmitted to the rocking levers.

Patent No. 685,834 was granted to R. P. B. Green November 5, 1901, for a variable speed gear of complicated, not to say defective construction, but interesting principle. One drawing of this specification is shown in Fig. 52. The pulley B is supposed to be the driving pulley, transmitting motion through the sleeve C to the hollow crank-wheel E. On the crankpin G are mounted three pinions having ball clutches, and meshing with these pinions are three racks, H. As the crank is rotated the pinions receive motion from the racks of varying velocity, depending upon the relative position of the crankpin and the racks. The pinion which receives the fastest motion grips the pin G, which also acts as a rotary member, and causes it to drive the shaft D through the train of bevel gears, thus making A the driven pulley. The bevel wheel F and connecting mechanism appear to be for shifting the crankpin G radially on E and thus change the speed rate. Another drawing in the same specification shows the motion taken from the pin G by means of a shaft containing universal joints.

Fig. 54 shows, diagrammatically and constructionally, a bicycle variable speed gear that was patented by A. Sharp, January 28, 1902, No. 692,077. The rear sprocket, A, may be shift-

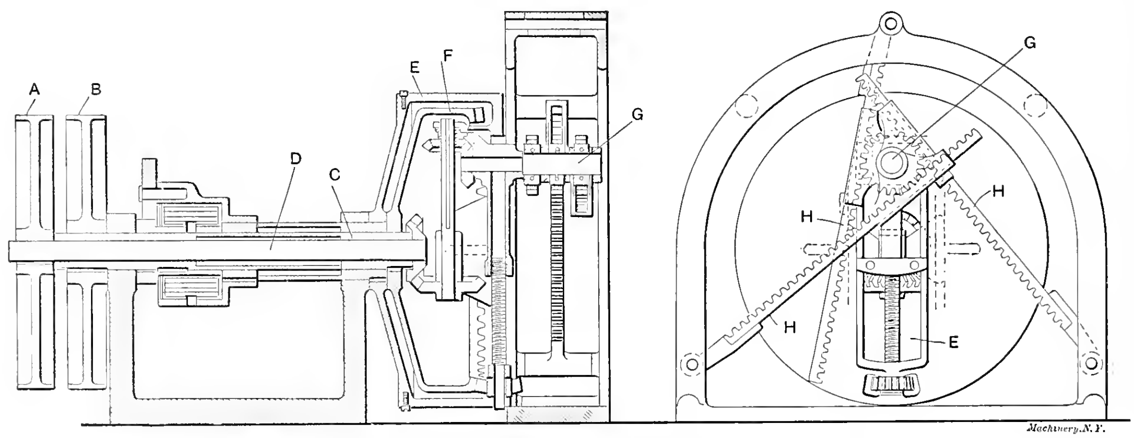


Fig. 52. R. P. B. Green's Changeable Speed Gear. Patent No. 685,834, November 5, 1901.

The variable power transmitter illustrated in Fig. 51 was patented by L. M. Dieterich, October 3, 1899, No. 634,327. In this device variation in the relative angular velocity of shafts $B\,B_1$ is obtained by a lateral displacement of the central member, F, which forms the bearing support of the disks, $A\,A_1$. Supposing that B is the driving shaft, it transmits motion to A through the medium of the friction pawls E which are pivoted on the jointed levers C. When A and shaft B are concentric it is evident that each pawl will act as a driver throughout a rotation; but when F carrying A and A_1 is displaced laterally, it then follows that only one of these pawls will be driven at a time, and through about one-third of the arc of a circle only. During the remaining two-thirds it will travel slower than the disk and so fall behind, since the outer ends of the links $C\,C$ are further removed from the center of the shaft B during two-thirds of its rotation. The converse of this action takes place on the opposite side with the disk A_1, levers C_1, and pawls E_1, which transmit the motion to the shaft B_1. From this condition it follows that B_1 is driven at the same rate as B when the disks A and A_1 are concentric with the driving and driven shafts; but when they are displaced sideways, the driven shaft runs at a faster rate than the driver, depending upon the displacement.

In the light of these devices previously described, the principal novelty of the patent 637,477, granted to W. H. Newman,

ed laterally with reference to the wheel, thus locating it either in a concentric or eccentric position thereto. In the diagram it is shown eccentric to the rear wheel hub in which position it should drive the rear wheel at a higher ratio than when

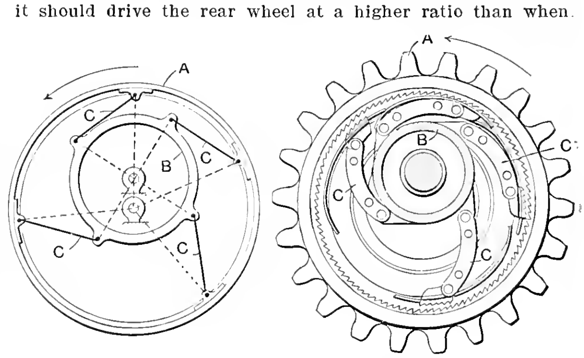


Fig. 54. Patent No. 692,077, granted to A. Sharp, January 28, 1902.

concentric. The inner face of the sprocket is provided with ratchet teeth for engagement with shoes having similar shaped teeth that are attached to the ends of the pivoted connecting members C. These are attached to the wheel hub B. The

side of the sprocket which is nearer the center of the wheel hub becomes the driving side; hence the angular velocity is greatest with a maximum displacement of the sprocket relative to the wheel hub.

A patent, No. 700,970, was granted May 27, 1902, to J. D.

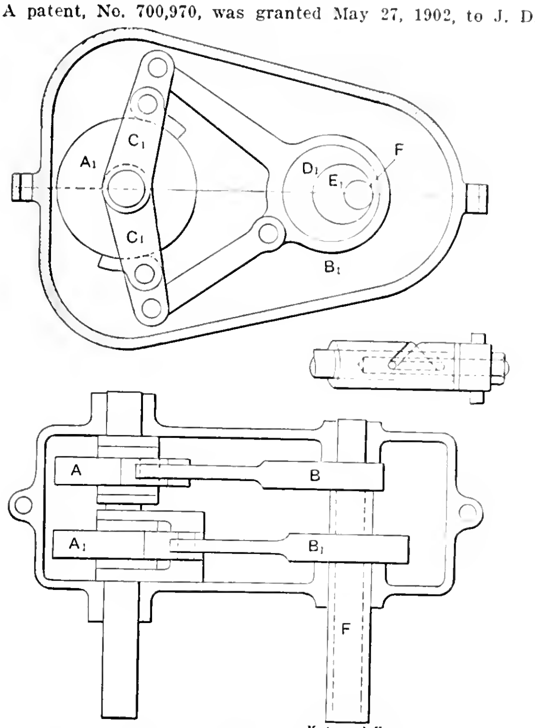


Fig. 53. Variable Speed Gear, Patented by W. H. Newman, November 21, 1899. No. 637,477.

McFarland, Jr., for an adjustable speed gear designed for the use of automobiles. It consists essentially of a shaft, A, having helical grooves or tongues, and a sleeve, B, sliding thereon. The helical tongues, as shown in Fig. 55, are made of varying pitch, the pitch changing from a straight line parallel to

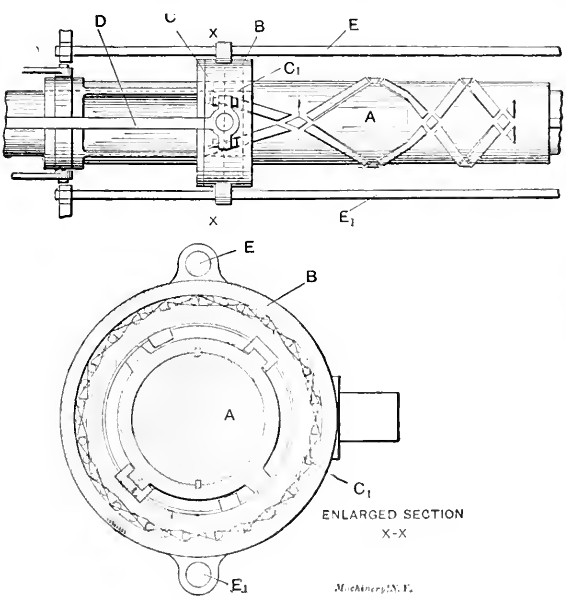


Fig. 55. Patent No. 700,970, granted to J. D. McFarland for May 27, 1902.

the axis to the maximum, by increments of say 10, 20, 30, 40 and 50 degrees. The lines of the tongues are continuous, however, and the pitch of each section is uniform. Both right and left-hand helices are provided, with which are engaged the elements of right- and left-hand nuts; the elements of one nut being secured to the inner ring C and the other to ring C_1. These rings have ratchet seats cut in their peripheries in which are placed balls, thus forming ball clutches. One ratchet is pitched in a right-hand direction and the other left-hand. Now, when reciprocating motion is communicated to sleeve B by means of the connecting-rod D, the guide rods $E\ E_1$ prevent the sleeve B turning with the helices on A, thus constraining the shaft A to rotate, the direction depending, of course, upon the relative arrangement of the ratchets and the

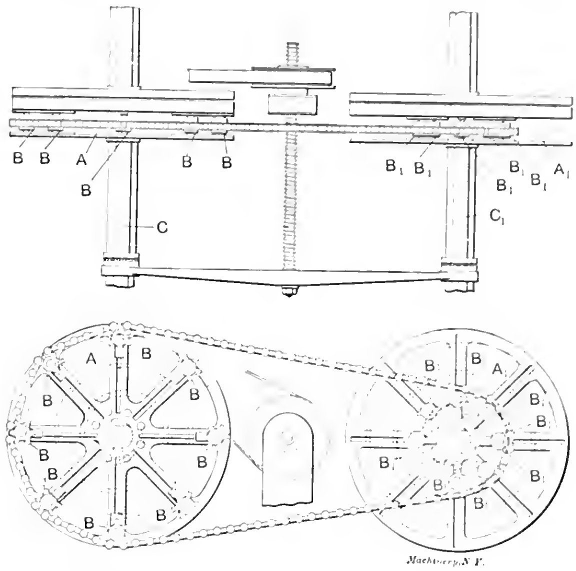


Fig. 56. Patented by W. N. Dumaresq, April 7, 1903. No. 724,450.

helical tongues. The reverse movement of the directing rod continues the motion in the same direction inasmuch as the other ratchet comes into action and transmits motion to the helix of opposite pitch. The position of sleeve B upon A determines the speed ratio, the ratio being greatest on the helix of greatest pitch.

The variable speed gear shown in Fig. 56 was patented by W. N. Dumaresq, April 7, 1903, No. 724,450. In this device the driving and the driven members, $A\ A_1$, consist of slotted disks carrying small sprockets. The drawing shows the use of sprockets and chain similar to that used on bicycles. The

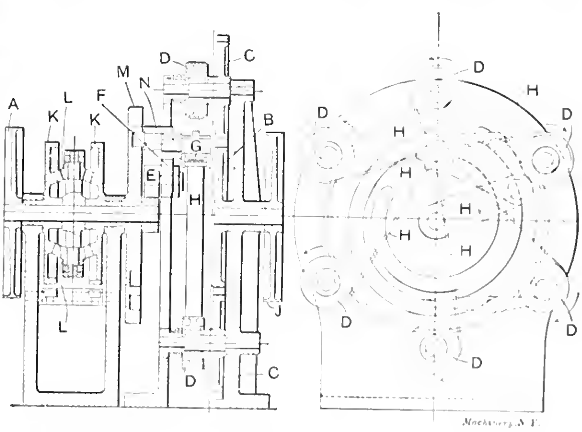


Fig. 57. Patent No. 741,904, granted to R. P. B Green, October 20, 1903.

sprockets, $B\ B_1$, are adjustable radially, by which means the driving and driven members may be expanded and contracted to vary the speed ratio. To compensate for the variation in pitch the sprockets are mounted on roller clutches so that each sprocket is free to adjust itself to the correct pitch as the wheels rotate. The adjustment, of course, takes place by each sprocket turning in a forward direction, as backward movement is prevented by the locking of the clutches. The mechanism by which sprockets are shifted radially consists

essentially of a scroll plate with which lugs on the sprocket mountings are engaged. These scroll plates are rotated by shifting an internal coarse-pitch screw, $C C_1$, longitudinally relative to the scroll plates, causing same to revolve independently of the slotted disk and thus change the position of the sprockets. This movement, of course, takes place simultaneously on both the driving and driven wheels and in opposite directions so that an even tension is maintained in the driving chain. It is apparent that this device is one form of expanding pulley adapted to the use of chain, thus making it positively driven by use of the roller clutch sprockets.

An improvement on patent No. 685,834 granted to R. P. B. Green, November 5, 1901, was granted to the same patentee October 20, 1903, No. 741,904. The power is transmitted to this device by means of pulley A, Fig. 57, which is mounted on a shaft carrying the crank E on its inner end. To this crank is pivoted a link, F, to which is attached the crankpin G. To the crankpin are connected a number of belts, H, which wind upon pulleys, D. These pulleys are retracted by coil springs so that the belts are kept under constant tension. As the crank wheel is revolved motion is communicated to pulleys D at varying velocities, the velocity of each, of course, depending upon the relative position of the crankpin and each pulley in turn. The coil springs also serve to engage toothed clutches formed on the side of each pulley and the adjacent side of the pinions C. As each pulley rotates at maximum velocity it acts as a driver for its mating pinion, which motion is transmitted to the gear B and thence to the driven pulley J. The device suggested in the cut for varying the speed consists of a differential gear. The gears $K K_1$ are provided with smooth peripheries for brakebands, the hub on which pinions L are mounted is keyed to the shaft and normally the combination rotates with it. Should it be desired, however, to change the position of crankpin G in order to vary the velocity ratio, a brake is applied to either K or K_1, thus retarding its motion and causing the snail cam M to move faster or slower than A, the consequence being that the crankpin is moved in or out relative to the center, thus changing the speed ratio. In none of these devices does the ratchet mechanism have control of the driven member if there is any tendency to overrun.

Fig. 1. Birds-eye View of B. F. Sturtevant Plant. Machine Shop is the Central Building with Saw-tooth Roof.

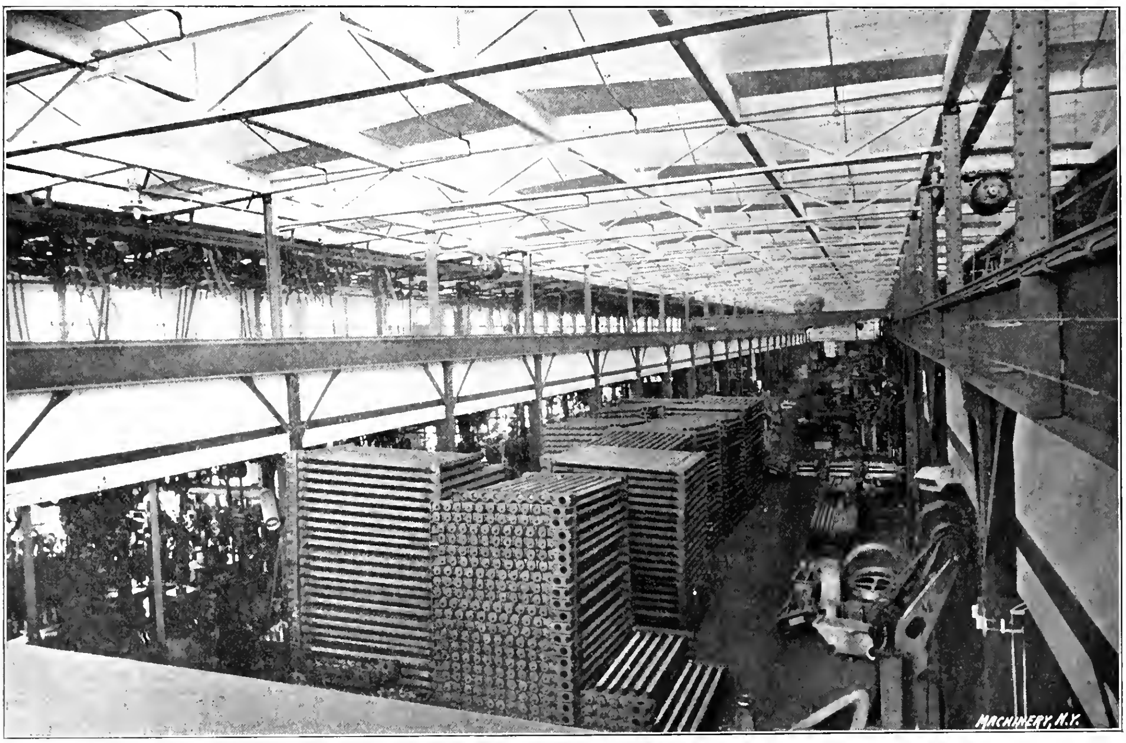


Fig. 2. Interior of Machine Shop. This Shop is Constructed on the Gallery Syetem, withWide Central Bay, but differs from other Buildinge of this Type in that a Saw-tooth Roof is used for Lighting the Central Bay and the Inner Sections of the Galleries.

Table IV gives a summary of the tests in this series and may be compared with Table II.

The relatively high values for the Hyatt 2 7-16 bearing must be due to a slight clamping of the rolls due to too close a fit, as was noted in some of the former experiments.

Under a load of 470 lbs. the Hyatt bearing developed an end thrust of 13.5 lbs. and the McKeel one of 11 lbs. This end thrust is due to a slight skewing of the rolls and would vary, sometimes even reversing in direction.

The babbitt bearing is a slight improvement over the cast-iron sleeve, but the difference is quite as apt to be due to improved lubrication (notice the variation in the averages for the various sizes in Table IV).

TABLE IV.

Values of Coefficient of Friction f. Speed 560 Revolutions per minute.

Diameter of Journal.	Hyatt Bearing.			McKeel Bearing.			Babbitt Bearing.		
	Max.	Min.	Ave.	Max.	Min	Ave.	Max.	Min.	Ave.
$1\frac{15}{16}$	.032	.012	.018	.033	.017	.022	.074	.029	.043
$2\frac{3}{16}$	.019	.011	.014	......	......	......	.088	.078	.082
$2\frac{7}{16}$	.042	.025	.032	.028	.015	.021	.114	.083	.096
$2\frac{15}{16}$	.029	.022	.025	.039	.019	.027	.125	.089	.107

In conclusion it may be said that the friction of the roller bearing is shown to be from one-fifth to one-third that of a plain bearing at moderate loads and speeds. It is also noticeable that as the load on a roller bearing increases the coefficient of friction decreases.

It was found by the experimenters that a slight change in the pressure due to the adjusting nuts was sufficient to increase the friction considerably. In the McKeel bearing the rolls bore on a cast-iron sleeve and in the Hyatt on a soft steel one. If roller bearings are properly adjusted and not overloaded a saving of from 2-3 to 3-4 of the friction may be reasonably expected.

* * *

Once there was a foreman who believed that "economy is wealth," and so thoroughly did he believe this maxim that he required his toolmakers to wear their files down to the last degree. Cochrane was making an unusually large die and the foreman's policy caused him to spend two or three weary days in filing out the die that would have been unnecessary if good, sharp files had been provided. He then and there resolved that when he escaped from the drudgery of the job he would devise a filing machine that would save other unfortunates from such slavery. The result is a machine which does the work of the human operator with an accuracy that the latter could never hope to equal. It is true that it works more efficiently with sharp files than dull ones, but if it is forced to use dull ones its cheerfulness is not at all affected. In this machine we have another proof, though none is needed, that it is the average American's unconquerable aversion to unnecessary manual labor that causes the activity of his "think tank" and the invention of the thousand and one devices calculated to lighten labor and to increase its efficiency.

* * *

When a crank-pin is forced into its disk it is held in place by the tension of the disk compressing the particles of the crank-pin, with such a grip that the friction usually holds it firmly against any ordinary strain. In fact, a crank-pin is usually held *too* firmly when for any reason it becomes necessary to remove one in the engine room, for the appliances necessary for generating the required pressure are rarely at hand. It does not avail to heat the parts for the pin and disk expand at practically the same rate so that the tension is not changed; but what may be done in case a pin is useless for further service, is to drill a hole through it longitudinally and tap each end of the hole for pipe connections. Then when the disk and pin are heated, the pin may be cooled rapidly from the interior and thus shrunk so that it may be pulled out with comparative ease. One of the contributors to a paper called "Wrinkles," which was presented at the June convention of the National Electric Light Association, describes this plan which was successfully employed by him.

THE WORM GEAR.

JOHN EDGAR

The worm gear has been bothering machine designers ever since its conception, having been discarded as unsatisfactory time and again, only to come to the front in further attempts to make itself useful. The last period of discussion was in relation to the helix angle. Mr. Halsey in his articles in the *American Machinist* on this subject has given data from a variety of different successful and unsuccessful examples, which show that the helix angle gives the highest efficiency when above 12 degrees, increasing gradually up to 45 degrees, and that all examples with an angle less than 9 degrees proved unsuccessful.

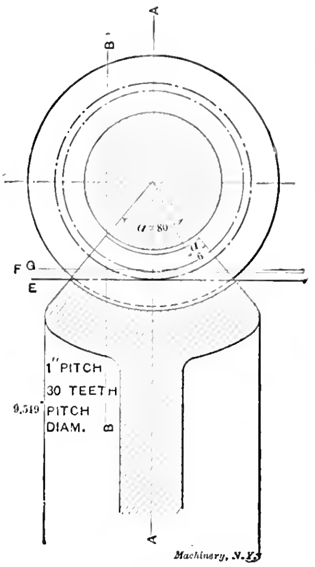


Fig. 1.

In the course of his articles no mention was made of the sizing of the gear blanks, so that one may rightly come to the conclusion that they were sized according to standard practice. This method locates the pitch line of the worm on a circle whose radius is smaller than that of the worm by an amount equal to one-half the working depth of the tooth. Where the working depth, as in standard practice, is equal to .6366 times the linear pitch, and when P' is the

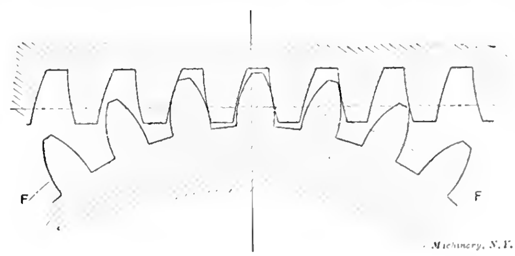


Fig 2.

linear pitch, D the outside diameter and D' the pitch diameter of the worm, this fact may be expressed by the following formula:

$$D' = D - .6366\,P'. \qquad (1)$$

In Fig. 1 we have a section through a worm and worm gear. The pitch circle for the worm according to standard practice is located as shown tangent to the line E, which is the pitch line of the worm gear. On inspection of the figure it is seen

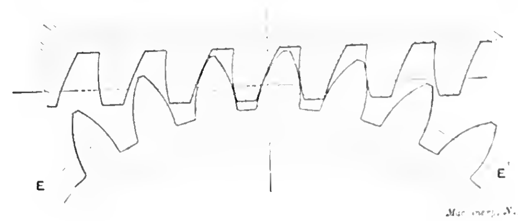


Fig. 3.

that while the addendum of the worm and worm gear are equal, at the center line A A, they are not at any other point along the pitch line, either to the right or the left: A section taken through the gear on the line A A would reveal teeth similar in shape to those of a spur gear of the same pitch and number of teeth. But how does this shape vary as we shift

this line either side of the central position? Let us show this by example, taking the case of a worm having a single thread of 1-inch pitch. By taking a section on line *B B* instead of the center line *A A* we obtain Fig. 2. This figure shows plainly that the faces of the teeth of the gear are considerably longer than the flanks. It is easily seen that the greater the angle α is, the greater will this difference be, and *vice versa*, until we reach the central position, where there is no difference. Therefore we see that this angle α plays an important part in the design of a successful worm gear.

This angle is not the only cause of distortion in the shape of the tooth. With a little thought it will be seen that the angle of the helix also is cause for further irregularity. To illustrate this we will take the case of a worm having the same pitch, but having three threads instead of one, giving a lead of 3 inches. A section of this at *B B* is shown in Fig. 3. These conditions have the effect of producing even longer faces than do those in the former case.

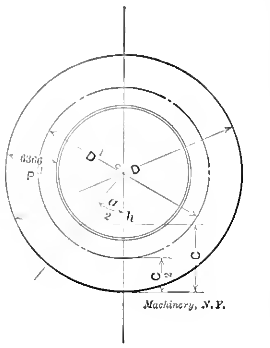


Fig. 4.

What can be done to remedy this defect? We can shorten the faces, but when we do that at this point we do so all along the face of the gear and thus change the shape at *A A*, where it is normal. Therefore, the best we can do is to divide the difference at the two extreme points—*A A* and *B B*. This can be done as follows: In an ordinary spur gear of standard proportions the pitch line is located at a point midway of the working depth. From Fig. 4, which shows the end view of a worm, we see that the total working depth is equal to *C*, so that from the foregoing statement the pitch line should pass through a point situated at a distance equal to one-half of *C* from the outside of the worm making *D'* the pitch diameter of the worm.

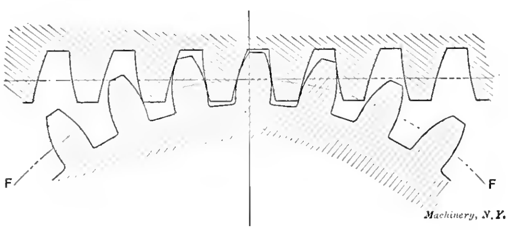


Fig. 5.

By an inspection of Fig. 4 we may derive the following formula:

$$C = \frac{D}{2} - \cos\frac{\alpha}{2}\left(\frac{D}{2} - .6366\ P'\right) \qquad (2)$$

Since $D' = D - C$, we may obtain the value of D' in terms of D, P' and α:

$$D' = \frac{D}{2} + \cos\frac{\alpha}{2}\left(\frac{D}{2} - .6366\ P'\right) \qquad (3)$$

Solving this last equation for D, we have the means for finding the outside diameter when D', P' and α are given:

$$D = \frac{2\ D' + 1.273\ P' \cos.\ \frac{\alpha}{2}}{1 + \cos.\ \frac{\alpha}{2}} \qquad (4)$$

Formulas 3 and 4 may be used for obtaining the pitch diameter of any worm when the outside diameter is known, and *vice versa*.

It is quite evident that the method given by Mr. Perrigo in the June issue for obtaining the pitch diameter of the gear is based on this principle, but it is only an approximation, the variance between its results and those of the formula increasing with the angle α. The difference for the example we have been investigating will be seen in Fig. 1 where *G* is the line as located by his method, *F* that by the formula; and *E* the standard location.

To show the difference this change in location of the pitch line makes in the tooth shape as compared with the usual practice, I have drawn sections at *B B* for both a single and a triple threaded worm of 1-inch pitch. Figs. 5 and 6, respectively, show these sections. Here we see that while the faces are yet considerably longer than the flanks the shape is improved. The difference between Fig. 5 and a normal section is very slight and hardly noticeable, and while the shape in Fig. 6 is somewhat freakish it has all the properties of a smoothly running gears.

But someone may ask what all this has to do with the durability of the gear. It is this: It has been proved that the friction of approach is much more in amount than that of the release. This friction of approach occurs between the face of the driven gear and the flank of the driver. Now if these particular elements of the tooth are extra long, the friction is proportionately increased over what it would be in a normal tooth. The friction of motion is always accompanied by wearing of the surfaces in contact; therefore in order to increase the life of the gear we must decrease the friction to a minimum. This we have done by locating the pitch line in accordance with the formula.

In order to illustrate the extent to which some designers go to eliminate the friction between the surfaces of the teeth in contact, I might cite the case of some special forms of clock gearing, where the driver is made with teeth having no flanks and the driven gear with teeth having no faces, fixing all the contact at the period of release. The reader may prove the importance of this point for himself by observing the wear on the teeth of a pair of gears that run constantly in one direction.

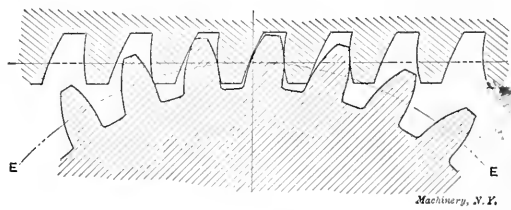


Fig. 6.

It would be interesting if Mr. Perrigo, and any others who have at hand data on successful and unsuccessful examples of this form of gearing, would analyze some of the most prominent cases. It would prove instructive as well as interesting.

The tooth curves in the above figures were obtained by the tracing cloth method described in Unwin's Machine Design, which time and space hinder me from giving here.

I would suggest that all those who have not done so, should obtain a copy of *Mr. Halsey's articles on the worm gear, as he gives some very important data, showing how unsatisfactory examples have been altered so as to prove satisfactory. All the examples have been taken from practice and have been in use in all parts of the country.

* * *

The handling of a railway car as though it were a huge spoon is an accomplishment which is daily demonstrating its effectiveness at coal wharves and other places where a large number of gondola coal cars have to be unloaded. The cars are progressively run into an unloading platform, which, after the car is rigidly clamped fast, is lifted and tilted to one side until the contents all pour out. A 50-ton car by this process can be clamped, lifted and tilted and returned to its original place in less than two minutes. To a certain extent the converse of this action is successfully being employed for loading box cars with coal, but the cradle, instead of tilting sideways, tilts longitudinally; thus allowing the coal which runs from a chute into the side door, to run first to one side of the car and then to the other as the car is tilted in the opposite direction.

* "Worm and Spiral Gearing," Frederick A. Halsey. Published by the D. Van Nostrand Co., New York. Price 50 cents.

CUTTING SPIRAL GEARS.

E. H. FISH.

E. H. Fish.

In taking up the subject of spiral gears with students at the Worcester Polytechnic Institute, we have experienced some difficulty over the formulas relating to their construction. If these trouble men accustomed to the use of trigonometry, they must certainly be confusing to shop men. As the explanation of the method of figuring these gears, which we have arrived at for the student's use, involves a minimum amount of mathematics, we feel that it may be of value to others.

As it is more convenient to adapt these gears to the standard diametral pitch cutters used for spur gears, we will consider the subject only from that point of view. This gives us at once the normal pitch; that is, the pitch measured perpendicular to the face of the tooth, and also the shape and depth of the tooth.

In the case of a spur gear, we cut the teeth at right angles with the base of the cylinder on which the gear is cut, as at *a* in Fig. 1. The space appears in its true size and shape on the base of the blank. If, now, we cut the teeth at some other angle, say at 30 degrees with a line parallel to the axis of the gear blank, as at *b* in Fig. 1, we see that the width of the space measured on the base is greater, and it will be greater still if the angle is increased. It is thus evident that the number of teeth that can be cut on a given cylinder decreases as the angle of the teeth with a line parallel with the axis of the gear increases.

Number of Teeth and Diameter of Blank.

Referring to Fig. 2, suppose the line $b\,c$ to be a part of the base of the cylinder and the two lines making the angle

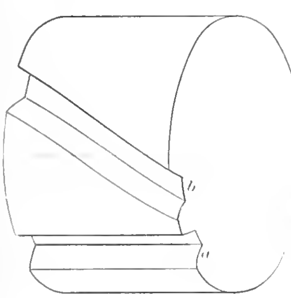
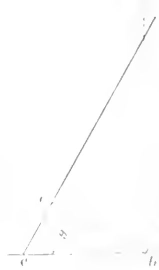


Fig. 1.



Machinery, N.Y.

Fig. 2

θ ($=\theta'$) with a line parallel with the axis to represent the center lines of two adjacent teeth. Then, $a\,b$ will represent the normal pitch, and $b\,c$ the circumferential pitch; but

$$a\,b = b\,c \cos\theta, \text{ whence}$$

$$b\,c = \frac{a\,b}{\cos\theta}.$$

The number of spur-gear teeth that can be cut in a blank of pitch radius, r, is expressed by the formula:

$$N = 2\,r\,P, \qquad (1)$$

where P is the diametral pitch and N the number of teeth.

From this we see that the number of teeth in a spiral gear of this pitch and pitch radius, and of angle θ, will be

$$N' = 2\,r\,P \cos\theta. \qquad (2)$$

Take as an example a gear to be cut 6-pitch, with teeth at an angle of 60 degrees to a line parallel with the axis of the gear; pitch diameter to be about $2\frac{1}{2}$ inches. Then, $r = 1\frac{1}{4}$; $P = 6$; $\cos\theta = 0.5$. Hence,

$$N' = 2 \times 1\tfrac{1}{4} \times 6 \times 0.5 = 7\tfrac{1}{2}.$$

As a gear of $7\frac{1}{2}$ teeth is impracticable for continuous rotation, we must make the number of teeth either 7 or 8. Suppose we make it 8. Then, to find the pitch diameter of the gear we use the same formula, but transposed as follows

$$r = \frac{N'}{2\,P \cos\theta},$$

from which we get, after substituting 8 for N',

$$r = \frac{8}{2 \times 6 \times \frac{1}{2}} = 1\tfrac{1}{3}.$$

The pitch diameter of our blank must, therefore, be 2 2-3 inches, the same as for a spur gear of 16 teeth. As we are using diametral pitch cutters, the addendum will be the same as for a spur gear of the same pitch. Adding $1/P$ to the pitch diameter on each side will make the whole diameter, 3 inches in this case.

Milling Spiral Teeth.

In order to mill the teeth, we must be able to set up the machine so to make, approximately, the correct advance per revolution of the work. This advance will be equal to the circumference of the blank, measured on the pitch line multiplied by the cotangent of the angle of the teeth. As this usually presents no difficulty to student or workman, we pass it over with simply saying that gears run together quite nicely, even if the lead as figured is not exactly obtainable on the milling machine. A difference of 4 or 5 per cent is not very noticeable.

After having set our machine to cut the desired spiral, we next wish to select the proper cutter. This will be, unless the angle θ is very small, quite a different cutter from that used for a spur gear of the same diameter, or of the same number of teeth. Brown & Sharpe advise turning up a blank of the size of the pitch diameter and laying on it a helix at right angles to the helix of the teeth of the gear to be cut, as in Fig. 3, fitting a cardboard template to the face of the cylinder along this curve, and then finding the diameter of the circle corresponding to this template.

The cutter should be such as will be suitable for a gear of this diameter and the given normal pitch. This is a sufficiently close method for gears of a large number of teeth, but requires considerable care for gears of 12 or less teeth. Moreover, we require a method that can be worked out entirely in the drafting room. Grant says that the cutter should be right for a spur gear having a number of teeth equal to the number of teeth in the spiral gear, divided by the cube of the cosine of the angle of the teeth. This gives an exact result, but he offers no explanation of his statement. The following, we hope, will seem a clear demonstration:

Demonstration of Grant's Formula.

It will be seen that what we wish to find at the start is a circle having the same radius as the helix, which is drawn on our pitch cylinder perpendicular to the teeth, as in Fig. 3. The angle of this helix will be $90 - \theta$ degrees. If R = radius of curvature of this helix, then from the well-known formula of analytic geometry for the radius of curvature of a helix, we have

$$R = \frac{r}{\sin^2(90 - \theta)} = \frac{r}{\cos^2\theta}. \qquad (3)$$

The demonstration of this formula will shortly be given for the benefit of those who enjoy mathematics.

Referring, now, to formula (1) and applying it to a gear of radius R, we have

$$N = 2\,R \times P = \frac{2\,r}{\cos^2\theta} \times P. \qquad (4)$$

For our spiral gear we found, by formula (2), that

$$N' = 2\,r\,P \cos\theta.$$

Dividing (4) by (2), we have

$$\frac{N}{N'} = \frac{2\,r\,P}{\cos^2\theta} \times \frac{1}{2\,r\,P\cos\theta} = \frac{1}{\cos^3\theta}$$

E. H. Fish was born in Worcester, Mass., 1870. He graduated from the Worcester Polytechnic Institute in 1892, after which he worked for the H. C. Fish Machine Works. He has held positions as foreman, draftsman, superintendent, and for the past two years instructor of drawing and machine design at Worcester Polytechnic Institute. His specialty is the design of machine tools.

or, $$N = \frac{N'}{\cos^3 \theta}.$$

Since N' is the number of teeth in our spiral gear and N is the number of teeth in a spur gear which has the same radius as the radius of curvature of the helix above referred to, this is the equivalent of saying that the cutter to be used should be correct for a number of teeth which can be obtained by dividing the actual number of teeth in the gear by the cube of the cosine of the tooth angle. Since the cosine of angle θ is always less than unity, its cube will be still less, so N is certain to be greater than N', which will account for the fact that spiral gears of less than 12 teeth can be cut with the standard cutters. The getting of the cube of cos θ may bother some, as the cubing of any fraction is apt to do, but a graphical method is given later in the article which, even if roughly laid out, will give sufficiently accurate results for this purpose. For the other uses of this graphical method, care must be used, or the results are not to be depended on.

Calculation of Velocity Ratio.

So far, we are able to cut the gear, once having decided on the number of teeth, pitch (or pitch diameter) and angle of

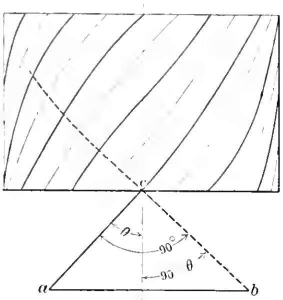


Fig. 3.

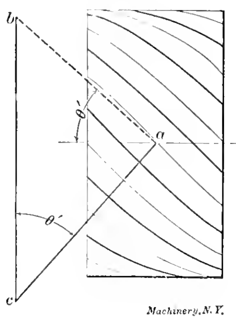


Fig. 4.

teeth, but in designing we almost always wish to transmit motion with some definite velocity ratio. If we were dealing with spur gears we would know that the ratio of speeds would be inversely proportional to the pitch diameters or the number of teeth. If the teeth were twisted or cut spiral on the surface and the axes were left still parallel, this same velocity ratio would obtain, but the moment we move the axes out of the same plane this convenient ratio ceases to exist. Then there can be but one point of contact of the pitch cylinders, consequently all motion must be transmitted as if through this one point if smooth running is to be attained. The actual motion of the tooth at this point must be at right angles to the axis of the gear, but it may be considered as the resultant of two motions, one of sliding parallel to the teeth, which we can see must happen since the two gears do not run in the same plane, and the other perpendicular to the teeth, which is the effective, or driving motion. This latter motion normal to the teeth must be same for both gears.

In the case of a driving gear of radius r and angle θ, the velocity of this point in a plane perpendicular to the axis will be $2\pi r n$, where n is the number of revolutions per minute of the driving gear. Let us consider the point c of the gear in Fig. 3. Assume the line $a\,b$ to represent the linear velocity and to be equal to $2\pi r n$. The line $c\,b$ is perpendicular to the tooth, and $a\,c$ parallel to the tooth. These three lines complete the triangle $a\,b\,c$, and therefore $a\,c$ will represent the sliding component of the point c, and $c\,b$ the motion perpendicular to the tooth. Then,

$$b\,c = 2\pi r n \cos \theta,$$

since in the triangle $a\,b\,c$ the angle $a\,b\,c$ is equal to θ.

This, also, is the velocity of the contact point of the driven gear in the same direction, or in a direction normal to the teeth of the driven gear. We will assume this gear to have a radius r' and angle θ'. Considering the gear in Fig. 4 to be the driven gear, with axis at right angles to the axis of the driving gear, we have

$$a\,c \text{ (Fig. 4)} = b\,c \text{ (Fig. 3)} = 2\pi r n \cos \theta.$$

The resulting motion perpendicular to the axis of the gear will then be

$$c\,b \text{ (Fig. 4)} = \frac{a\,c}{\cos \theta'},$$
$$= \frac{2\pi r n \cos \theta}{\cos \theta'}$$

This is the linear velocity of the point a; to get the number of revolutions of the driven gear we divide by the circumference of the driven gear, which is $2\pi r'$, giving

$$n' = \frac{2\pi r n \cos \theta}{2\pi r' \cos \theta'},$$

$$\text{whence } \frac{n'}{n} = \frac{r \cos \theta}{r' \cos \theta'}.$$

That is, the relative motion of the two gears is inversely proportional to the product of their diameters and the cosines of the angles of their teeth.

If both are 45-degree gears, this last factor becomes inoperative, and the gears produce motion in the same ratio as spur gears of the same sizes. The same is also true if the axes are parallel, for θ and θ' then become equal.

If the axes are at right angles, $\theta - 90 = \theta'$, and $\frac{\cos \theta}{\cos \theta'} = \frac{\cos \theta}{\sin \theta} = \cot \theta$, whence: $\frac{N}{N'} = \frac{r}{r'} \times \cot \theta$.

This property of spiral gears, of having a varying velocity ratio for both size and angle, is valuable, in that it enables one to obtain varying velocity ratios with the same size gear. For example, suppose we have two gears, one of 8 teeth and one of 16 teeth, both 45-degree gears, on axes at right angles. The velocity ratio is 2 to 1. If, now, we want a velocity ratio of 3 to 1 on the same axes with the same size gears, we use the formula last arrived at,

$$\frac{N}{N'} = \frac{r}{r'} \cot \theta, \quad \text{or,} \quad \frac{1}{3} = \frac{1}{2} \cot \theta,$$

$$\cot \theta = \frac{2}{3} = 0.6666.$$

θ will then be 56° 19′ and θ' will be 33° 41′.

If we use cutters of the same pitch as before, N and N' will become fractional numbers, thus making impossible condi-

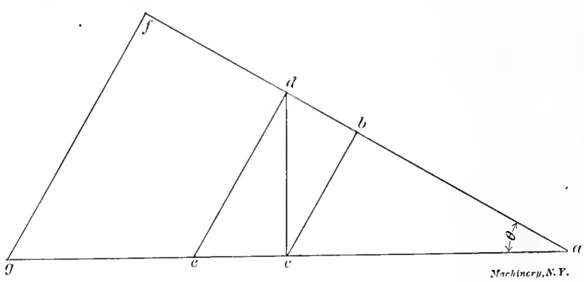


Fig. 5.

tions for practical use. It will, then, be necessary to use a fractional pitch cutter. To find what this cutter should be, decide on the number of teeth to be used in each of the two gears to give the desired new velocity ratio of 3 to 1; then solve formula No. 2 for P, substituting the required data from either of the two gears.

The relation between the angles of the shafts and gear teeth will be readily understood by a little thought. In gears whose axes are at right angles we have seen that the sum of the angles of the gear teeth is equal to 90 degrees, the angle of the shafts. This is true for any gears whose spirals are both right-hand or both left-hand. Carrying this to an extreme, we find that if the tooth angles become zero degrees (as in spur gears), the shaft angle becomes 180 degrees, or the shafts are parallel. If one gear is right-hand and the other left-hand, then the angle of the shafts will be equal to the difference of the tooth angles. If the gears have their teeth at equal angles, but one right-hand and one left-hand, then the shaft angle will

be zero; that is, the shafts are parallel and the gears are twisted gears, or Hooke's gears.

The annexed figure, while it is innocent looking enough, contains a solution of all the bothersome points of the figuring of spiral gears to be cut with the usual diametral pitch cutters.

To illustrate the use of the figure, we will take as an illustration a 24-tooth gear of 30-degree spiral angle, to be cut with an 8-pitch spur-gear cutter.

Lay off $a\,b = 3$ inches, the diameter of a spur gear of 24 teeth, 8-pitch. Lay off the angle θ 30 degrees as shown and erect a perpendicular at b to $a\,b$, intersecting $a\,c$ at c. The line $a\,c$ will be the pitch diameter of the required spiral gear (3.46 inches). The outside diameter will be equal to this diameter plus $\frac{2}{P}$, as in spur gears (3.71 inches). The depth of tooth will be the same as for a spur gear of the same pitch.

Extend $a\,b$ and $a\,c$. At c erect a perpendicular to $a\,c$, meeting $a\,b$ at d. At d, in turn, erect a perpendicular to $a\,d$, meeting $a\,c$ at e. $a\,e$ will be the diameter of a spur gear having the correct number of teeth from which to choose a cutter to cut our spiral. In this case the diameter is 4⅝ inches, corresponding to a 37-tooth gear. So we will use the same cutter to cut our 24-tooth spiral gear as that we would use to cut a 37-tooth spur gear.

Extend, in turn, $a\,d$ and $a\,e$ till a line, of length equal to $a\,e$, drawn perpendicular to $a\,d$ will just meet $a\,c$, as $f\,g$; then $a\,f \times \pi$ will be the pitch of the spiral to which we should set the milling machine (in this case, 18.85 inches). The diagram depends on the following facts relating to spiral gears.

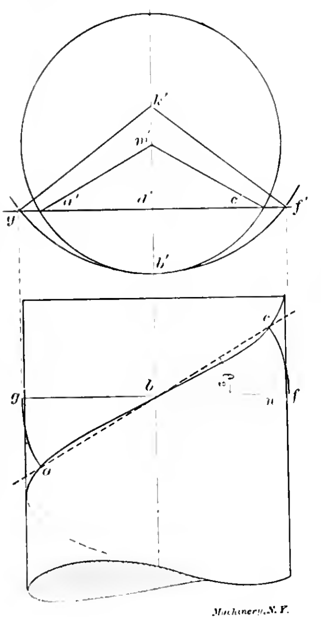


Fig. 6.

(1) $\frac{b\,a}{a\,c} = \cos\theta = \frac{\text{diam. spur gear}}{\text{diam. spiral gear}}$.

(2) $a\,c = \frac{b\,a}{\cos\theta}$

$$a\,d = \frac{a\,c}{\cos\theta} = \frac{b\,a}{\cos^2\theta}$$

$$e\,a = \frac{a\,d}{\cos\theta} = \frac{b\,a}{\cos^4\theta}.$$

which corresponds to equation 3 above.

(3) $\frac{\text{Pitch of first helix}}{\text{Circumference of pitch cylinder}} = \tan(90^\circ - \theta)$

Divide by π and transpose

$$\frac{P}{\pi} = \text{diameter of pitch cylinder} \times \frac{f\,a}{f\,g}$$

$$P = \frac{f\,a}{f\,g} \times (a\,c = f\,g) \times \pi = f\,a \times \pi$$

Therefore pitch of first helix $= f\,a \times \pi$.

Proof of Formula No. 3.

For the proof of formula No. 3, $R = \frac{r}{\cos^2\theta}$, where R = radius of curvature of a helix.

r = radius of the cylinder on which the helix is drawn, and θ is the angle of the helix with a line parallel to the axis of the cylinder, we have:

In Fig. 6 is a cylinder of radius $m'\,c' = r$, on which is drawn a helix. We have assumed three points, a, b and c equidistant on the helix, the middle point, b, being taken at the extreme front of the helix, for convenience only.

We wish to draw a circle passing through the three points, a, b and c. To do this we have revolved the two outside points into the same horizontal plane as b, placing a at g and c at f. We represent these points in the top view by g' and f'. Through g', b' and f' we draw a circle having its center at k' and radius $k'\,f'$, which we will call R_2. This circle will be represented in the front view by the horizontal line g to f. The original position of this circle in the front view is represented by the straight line a to c. The angle of these two lines we will call θ_2. Remember that this is not the angle of the helix with the base, but is the angle of the original plane of the circle through a, b and c with the horizontal.

(1) $b\,n = d'\,c' = b\,c\cos\theta_2$

(2) $b\,c = b\,f = d'\,f'$

Then,

(3) $d'\,c' = d'\,f'\cos\theta_2$

Squaring,

(4) $(d'\,c')^2 = (d'\,f')^2\cos^2\theta_2$

(5) $(d'\,c')^2 = (m'\,c')^2 - (m'\,d')^2 = r^2 - (m'\,d')^2$

(6) $(d'\,f')^2 = (k'\,f')^2 - (k'\,d')^2 = R^2_2 - (k'\,d')^2$

Substituting (5) and (6) in (4), we have,

(7) $r^2 - (m'\,d')^2 = [R^2_2 - (k'\,d')^2]\cos^2\theta_2$

$m'\,d' = r - d'\,b'$

(8) $(m'\,d')^2 = r^2 - 2\,r\,(d'\,b') + (d'\,b')^2$

$k'\,d' = R_2 - d'\,b'$

(9) $(k'\,d')^2 = R_2^2 - 2\,R_2\,(d'\,b') + (d'\,b')^2$

Substituting from 8 and 9 in 7 we get:

(10) $r^2 - r^2 + 2\,r\,(d'\,b') - (d'\,b')^2 =$

$$[R_2^2 - R_2^2 + 2\,R_2(d'\,b') - (d'\,b')^2]\cos^2\theta_2$$

cancelling we have,

(11) $2\,r - d'\,b' = (2\,R_2 - d'\,b')\,\mathrm{cor}^2\,\theta_2$.

This expression is true for any three points equidistant on the helix. Let us remember that the radius of curvature for any curve is the radius of the circle passing through any three consecutive points. We will accordingly consider points a and c moved up so that they become consecutive points with b and see what the effect is on equation 11.

r will remain constant.

$d'b'$ will become practically zero on each side of the equation and may be neglected.

R_2 becomes R, the radius of curvature of the helix, and

θ_2 becomes θ, the angle of the helix.

Substituting these values in (11), we have,

(12) $2\,r = 2\,R\cos^2\theta$

$$\text{or, } R = \frac{r}{\cos^2\theta}$$

* * *

4,000 KW. GAS ENGINE DRIVEN GENERATOR.

The station of the California Gas and Electric Corporation used for the operation of the United Railways of San Francisco will shortly be equipped with three generators of 4,000 kilowatts capacity each, driven by gas engines. The latter, which will be the largest yet made, will be built by the Snow Steam Pump Co. The generators will be built by the Crocker-Wheeler Co., and will be of the type developed by Brown, Boveri & Co. in Switzerland. The generators will be capable of working as motors in starting the engines that drive them.

* * *

One of the surprising things learned about friction in the investigations conducted with the air-brake is that the coefficent of friction continuously and regularly declines as the speed increases. The observed coefficient of friction between a cast-iron brake shoe and a chilled wheel is 0.111 at 55 miles per hour, and from the data acquired it is calculated that the coefficient would be 0.105 for 60 miles per hour; 0.085 for 85 miles per hour; and 0.072 for 100 miles per hour. In short, the frictional resistance of a bearing should be less with no lubricant at all when running with a peripheral speed of 100 miles per hour than it is usually with the best lubricants, running at ordinary speed.

THE NEW GISHOLT FOUNDRY.

About a year ago the Gisholt Co., Madison, Wis., completed a new foundry building, which is a good example of a modern foundry equipment, designed for the needs of a good-sized machine tool business. The main building is 120 × 240 feet, and is constructed with a steel frame and brick skin, therefore being of fireproof construction. No wood whatever was

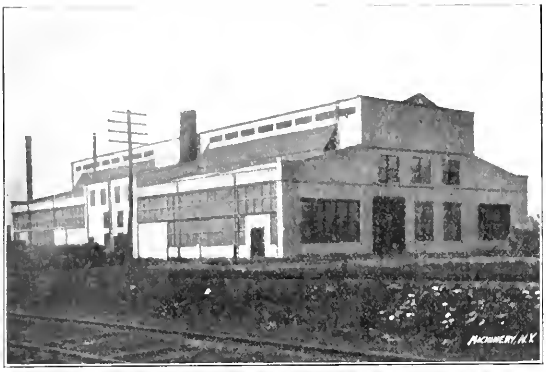


Fig. 1. The New Foundry of the Gisholt Co.

used in the building, save in the window frames and doors. The building is located on a plot of such size that future additions may be made in harmony with the general plan of plant enlargement. At present only one cupola has been provided, which has a capacity of 20 tons per hour. Space has been provided for a second cupola when the need shall demand it. The floor is served by a 20-ton electric traveling crane, and

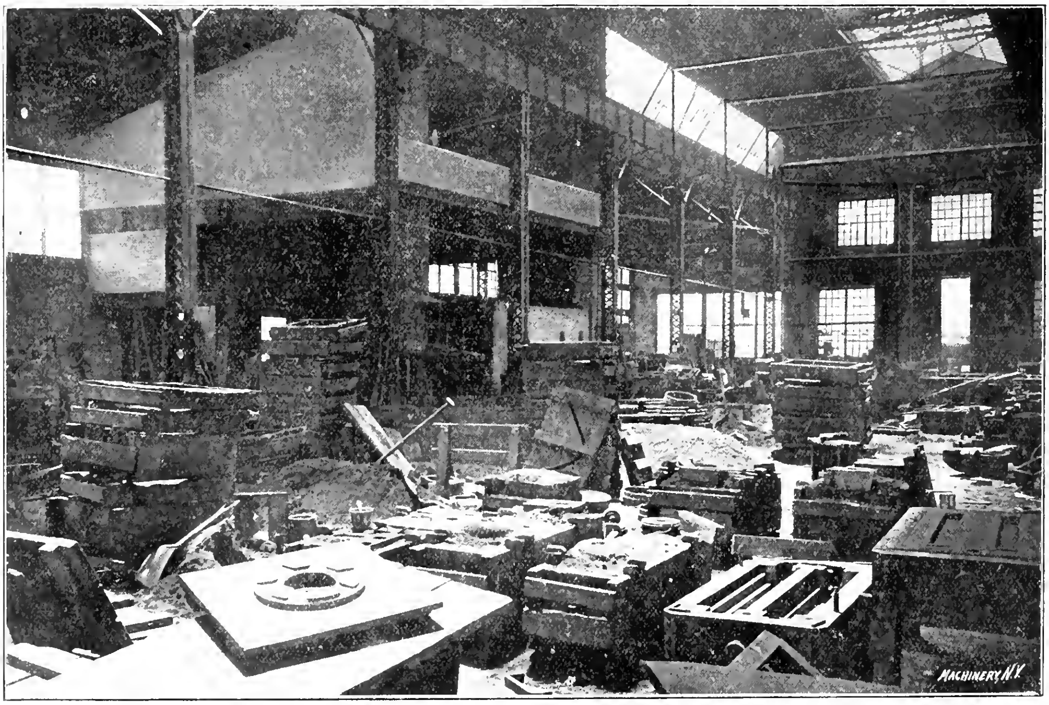


Fig. 2. Interior of the Foundry.

electric hoists, sand shakers, special iron flasks, core-making machines, etc., are a part of the up-to-date equipment. The exterior view, Fig. 1, shows that a large part of the wall space is glass, and the lighting is consequently very good. A feature of the roof construction is that the glass sides of the monitor are set in an inclined position, thus probably giving a considerably better diffusion of the light coming from this source than is possible when the sides are vertical. Nearly one-third of the top of the monitor roof is glass which, with the other sources, causes the light to come in from all directions, thus avoiding the casting of dense shadows on almost any part of the foundry floor; in short, a man does not stand in his own light, no matter in what part of the building he may be working, or scarcely in what position. This condition is evident from the view, Fig. 2, which should convey some impression of the extreme contrast between this building and the typical foundry interior.

Adjoining the foundry, and connected with it by a narrow gage track, is the casting storage building, a structure 100 feet wide and 200 feet long. The storage building is equipped with a traveling crane and hoists for handling heavy castings. The tumbling and cleaning rooms are in a separate building and the tumbling barrels are electrically driven. The pattern shop is in another building, 125 feet wide and 210 feet long. The system of buildings is connected by an industrial railway which connects it with the main machine shop across the street. Standard gage switches connecting the foundry and machine shop are also provided from the adjoining tracks of the Chicago, Milwaukee & St. Paul Railway.

* * *

The matter of taking up foreign patents is often a perplexing one to a manufacturer, as in many cases he does not expect to exploit the foreign market, and even if he does so, he is willing to do it in the open market without the advantage of foreign patent protection. The cost of taking out foreign patents, and the taxes and other charges, in some countries make them a burden to such an extent that it is often considered unprofitable to take them out, even on meritorious inventions. In a recent report, Mr. Frank Mason, United States Consul-General at Berlin, Germany, refers to the foreign agents' side of the question. From this point of view, it is very desirable that American goods which are to be sold in foreign markets, especially in Germany, shall be patented in those countries. It is hardly fair to ask the selling agent to spend his time doing missionary work in securing a market for unpatented articles, for as soon as it has become introduced, other manufacturers will at once enter the field, and rob the selling agent of the fruits of his endeavor. Then, again, there is the customer to consider, who runs the risk of buying a lawsuit with his machine or other purchase.

TECHNICAL READING AND FORMULAS.—1.

C. F. BLAKE.

I. General Remarks on Self-Education.

C. F. Blake.

There are several ways of obtaining an education: The easiest and, until recent years, the usual way is to begin at the age of seven and continue steadily at school till the age of twenty-four, at father's expense. It is a fortunate fact that education is by no means unattainable otherwise; indeed many of the greatest and most widely useful educations the world has known have been obtained almost without a look at the inside of a school. A second method, quite modern, is the correspondence school—most excellent in many respects, yet not completing the available ways of obtaining an education. For the purposes of this paper the final method is that of self-education. The writer has obtained a very large share of his education in this manner, and has, as well, assisted others to do the same, and it is to explain the possibilities of this method and to plant the seed of self-help elsewhere that these papers are undertaken. They are divided into four heads dealing with the following subjects:

1. Present introduction, explaining general methods to be followed.
2. Technical reading, journals, catalogues and formulas.
3. Strains set up in machine materials, and strength of materials to resist them.
4. Graphical methods in use in machine designing and technical writing.

This is an alluring subject, and it is difficult to know where to draw the line. Indeed it would be impossible to stop were it not for the limitations of space, as well as the deep-seated idea the writer holds that nothing is to be considered worth while that is made too easy. Consequently it is not our intention, even were it possible, to open wide the door of knowledge. It is the aim of these papers to start the ambitious young man of sufficient grit upon a path which, if rightly followed, will in the future surely place him on par with those more fortunate men of his age who have enjoyed a college education, and to leave him in a position to continue to read and study and to understand the technical discussion and articles on design which appear in the technical press.

Engineering education does not consist in knowing things mechanical—very far from it. It consists only in knowing where to find technical literature upon any given subject when it is wanted, and knowing how to read it when it is found. Therefore the first thing needed by our student is a place to store his newly acquired knowledge, aside from his head. The writer's first attempt in this line resulted in a book having black canvas covers and a flexible back. Tapes were provided to lace in the leaves, which were made of fairly heavy cardboard, perforated for the tapes, and having a flexible strip along the perforated edge to enable the leaves to turn back properly.

Twenty-six alphabet leaves were made similar to those in dictionaries and memorandum books, and a supply of extra leaves kept on hand.

Clippings from papers and catalogues were pasted on blank leaves and inserted under the proper letter, also notes and formulas received from others were written in, making the book a record of past work and study. The book, finally becoming too large to be convenient and too small to hold everything to be preserved, gave way to the card index and filing case. A card index outfit large enough to answer all requirements for a long time may be purchased for \$1.25 and a filing box for \$1.50. These include all index cards, blank cards, and envelopes for clippings.

Having provided a systematic way to file our clippings, we are ready to consider the sources of the same. First subscribe for one or two of the leading technical journals devoted to your line of work. Make a practice of sending for catalogues of machinery manufacturers, and file them in the filing box. Many catalogues present, besides the goods manufactured, tables and data of value. If you can clip out these tables and file them in the card index without destroying the catalogue, do so; if not, make an entry in the card index to show where they may be found before filing the catalogue. Always write your name in the catalogues, for as the file grows, you will find demands upon it from others, and this will aid in keeping the file intact.

Remember that a catalogue received implies confidence on the part of the sender that it will eventually prove of use to him by bringing his goods before possible purchasers, and for this reason, as well as for your own convenience, all catalogues received should be listed and filed.

Duplicate clippings, such as tables, may often be exchanged with others, and thus our files are enlarged. This is not meant to encourage a mere mania for collecting—far from it. We should so study all data filed as to understand it at the time, and if found difficult, make such notes as will readily recall the study to our minds in the future.

II. Technical Reading and Formulas.

The first thing to be done in preparation for study, and for reading the technical papers, is to become familiar with the *engineering language*. The *spoken engineering language* is of course the native tongue of the country, with, however, plenty of new words to master; but the *written engineering language* consists very largely of symbols, so like those of higher mathematics in appearance as often to discourage the beginner from further efforts. In the *written engineering language* rules, instead of being written in the native tongue, are expressed by combinations of these symbols, and when so expressed are called formulas.

Now, the mathematician when deriving a formula, uses the same symbols as the engineer when writing a formula, and if we accept the work of the mathematician as correct, we need pay no attention to the use of these symbols in deriving formulas, but give our attention to learning to read the symbolic language of the engineer with sufficient ease to enable us to follow the operations called for by any formula we may wish to use.

The following table exhibits in the first column the symbols most frequently met with; in the second column the arithmetical equivalent of the symbols is given, assuming that $a = 2$ and $b = 4$; in the third column the symbols are expressed in English to give the proper method of reading the symbols.

TABLE NO. 1.

$a = 2 \quad b = 4$		a equals 2 b equals 4
$a + b = c$	$2 + 4 = 6$	a plus b equals c
$b - a = d$	$4 - 2 = 2$	b minus a equals d
$a \times b = e$ $a \cdot b = e$ $a\,b = e$	$2 \times 4 = 8$	a times b equals e, or a, b equals e
$a\,(a + b) = f$	$2 \times 6 = 12$	a into a plus b equals f
$b \div a = h$ $\frac{b}{a} = h$	$\frac{4}{2} = 2$	b divided by a equals h, or b over a equals h
$a < b$ $b > a$	$2 < 4$ $4 > 2$	a is less than b b is greater than a
$b : a :: f : c$ $\frac{b}{a} = \frac{f}{c}$	$\frac{4}{2} = \frac{12}{6}$	b is to a as f is to c b divided by a equals f divided by c b over a equals f over c
$a^2 = b$	$2 \times 2 = 4$	a square equals b
$b^3 = k$	$4 \times 4 \times 4 = 64$	b cube equals k
$\sqrt{b} = a$	$\sqrt{4} = 2$	square root of b equals a
$\sqrt[3]{e} = a$	$\sqrt[3]{8} = 2$	cube root of e equals a

Let us now take the simple case of finding the area of a circle whose diameter we know. Expressed in English the rule is: Multiply the diameter by itself, then multiply the resulting product by 0.7854. The result is the area of the circle. If the diameter is expressed in inches the area will be expressed in square inches. The corresponding engineering

expression is

$$A = 0.7854\, d^2 \quad (1)$$

where A = the area in square inches,

d = the diameter in inches.

Now, to solve this expression for a particular case, suppose we wish to know the area of a circle nine inches in diameter. We simply substitute for d^2 its numerical value, and perform the indicated operations, thus:

$A = 0.7854 \times 9 \times 9 = 0.7854 \times 81 = 63.617$ square inches.

Take as another example the formula for the indicated horse power of an engine:

$$\text{HP} = \frac{P\,L\,A\,N}{33{,}000} \quad (2)$$

where P = the mean effective pressure in pounds per square inch,

L = the length of stroke in feet,

A = the area of the piston in square inches,

N = the number of strokes per minute.

The whole information as to how to determine the indicated horse-power of an engine is given in the above small space, while to write the same in English would require half a column or more of the space at our disposal.

Take the case of an 8 x 10-inch engine running at 100 revolutions per minute under 125 pounds mean effective pressure; here we have:

P = 125 pounds,

$$L = \frac{10 \text{ inches}}{12} = 0.833 \text{ feet,}$$

$A = 0.7854 \times 8 \times 8 = 50.26$ square inches,

$N = 100$ rev. per min. $\times\, 2 = 200$.

Then,

$$\text{HP} = \frac{125 \times 0.833 \times 50.26 \times 200}{33{,}000} = 31$$

A reader of engineering literature frequently encounters trigonometrical expressions, and must know how to treat them. They are in reality about the easiest of all engineering terms to deal with, although often proving a stumbling block to beginners because of their peculiar names and unfamiliar looks. They are always used in connection with a given angle, and are called the *trigonometrical functions* of the angle.

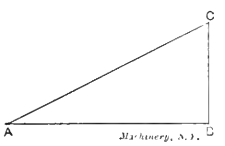


Fig. 1.

They are as follows for angle A in Fig. 1: in the formulas where the sides are given as AC, CB, etc., the length of the side in inches is meant:

TABLE NO. 2.

CB = opposite side, AB = adjacent side, AC = Hypotenuse.

Called.	Written.	Rule.
sine of A	$\sin. A = \frac{C\,B}{A\,C}$	opposite side divided by hypotenuse.
cosine of A	$\cos. A = \frac{A\,B}{A\,C}$	adjacent side divided by hypotenuse.
tangent of A	$\tan. A = \frac{C\,B}{A\,B}$	opposite side divided by adjacent side.
cotangent of A	$\cot. A = \frac{A\,B}{C\,B}$	adjacent side divided by opposite side.
secant of A	$\sec. A = \frac{A\,C}{A\,B}$	hypotenuse divided by adjacent side.
cosecant of A	$\text{cosec.}\ A = \frac{A\,C}{C\,B}$	hypotenuse divided by opposite side.

Tables will be found in the hand books giving the numerical values for these expressions for all angles. The following is an example of such a table:

Angle.	sine.	cos.	tan.	cot.
10 degrees	0.1736	0.9848	0.1763	5.671
11 degrees	0.1908	0.9816	0.1943	5.144
12 degrees	0.2047	0.9781	0.2125	5.704

There is also a proposition in geometry so commonly used as to demand recognition whenever met. It is called the rule of the squares of a right angle triangle. In Fig. 2 let $A\,B\,C$ be a right angle triangle, having angle $C\,B\,A$ for the right angle. If we draw a square on each side as shown, the rule says that the area of $A\,D\,E\,C$ is equal to the area of $A\,B\,H\,I$ plus the area of $B\,C\,F\,G$. The rule is usually expressed thus: The square on the hypotenuse is equal to the sum of the squares on the other two sides. Given expression as a formula the rule is:

$$A\,C^2 = A\,B^2 + B\,C^2 \quad (3)$$

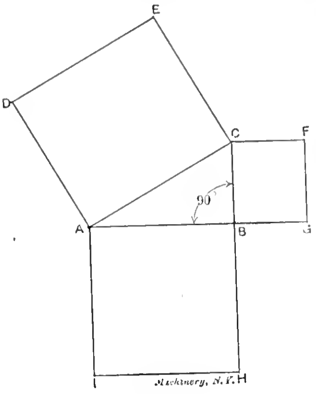


Fig. 2.

With the help of this formula and the trigonometrical functions of the angles, we can solve any problems of the right angle triangle, as illustrated in the following example. We have an inclined plane or approach like Fig. 3 to make, and wish to know the angle and the length of the incline, knowing the height BC to be $23\frac{1}{4}$ inches, and the length AB to be 10 feet.

$A\,B = 10$ feet $= 120$ inches,

$$\tan.\, a = \frac{C\,B}{A\,B} = \frac{23.25 \text{ inches}}{120 \text{ inches}} = 0.194$$

Looking in the table of functions of angles we find opposite 0.194 in the column of tangents, that the angle a is 11 degrees. From (3) we have

$$A\,C^2 = A\,B^2 + B\,C^2 = 120^2 + 23.25^2 = 14400 + 540.56 = 14940.56.$$

then,

$$A\,C = \sqrt{14940.56} = 122.3 \text{ inches.}$$

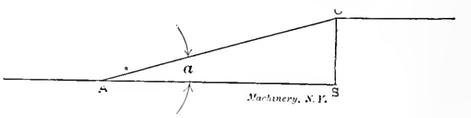


Fig. 3.

Thus we find the angle of inclination is 11 degrees, and the length of the incline is 122.3 inches. A table of square roots will be found in any of the handbooks.

* * *

THE ENGINEERS' DEPARTMENT OF A LARGE HOTEL.

STORRS ELY EMMONS.

In one of the largest hotels in this country, if not in the world, where the number of employees reaches the neighborhood of fifteen hundred, especial attention must be paid to the needs of the mechanics and engineers whose duty it is to keep the house running smoothly in a mechanical sense. For the accomplishment of this end such a hotel must have a thoroughly equipped and systematized engineers' department.

We can readily realize the magnitude of the duties coming under this department when we learn that the hotel in question is provided with eighteen electric and an equal number of hydraulic elevators, an ice plant of far greater capacity than that found in many cities, a large electric plant, pumps for air, water and sewerage, as well as a special set of fire pumps, and a large boiler room equipped with automatic stokers and ash hoists. This department is also responsible for the installation and maintenance of telephones, pneumatic tubes, heating, ventilating, plumbing, clocks, bells and in fact everything of a mechanical nature in the building. This department occupies the entire sub-basement of the hotel and has in its employ over one hundred mechanics, electricians, steamfitters, plumbers, engineers, etc.

The head of such a department must, of necessity, be a man of exceptional executive ability, having a thorough knowledge of all the different branches of engineering. On the pay-roll he is known as chief engineer, but by his associates he is called simply "the chief." Without the liberal

use of systems it would be impossible for him to keep in touch with the men under his charge and with their duties.

In this hotel, which was the first in New York City to organize a mechanical store room, the store room is in no way connected with the steward's but comes under the engineer's department. This department is well stocked with

Date Mar. 14-03 **Order No.** 31426

For Electrician.

Nature Fan. **Location** Room 1672

Remarks Rush.

Job Completed Chas. Murdock. 3/14/03

Fig. 1. Specimen Order Form.

valves, fittings, plumbers' supplies, waste, engine, dynamo and motor spare parts, electrical supplies and general hardware, in fact, everything that can be called for for rapidly making repairs, also tools and machine parts for the supply of the machine room. The material in the bins of this store room is kept run of by the use of the card system. Each

TIME SHEET.

Date Mar. 14-1903.

Name Chas. Murdock.

Time Number 412

Department Elect.

Job Number.	From	To	Hrs. Min.	Rate.	Total.
31426	8 :05	8 :30	25	.20	.09

Fig. 2. Specimen Time Sheet

item has a high and low stock number, between which points the amount of material in stock fluctuates. As the stock of any material reaches the low mark, the storekeeper makes out a requisition which, after being O. K.'d by the chief is sent to the steward's department, corresponding to the purchasing department of a manufacturing establishment. This department in turn issues the order on the outside firm from which the material is to be obtained. In the selection of the best places for purchasing materials, etc., the steward's department acts in accordance with the advice and recommendation of the chief. When the material is received, the storekeeper gives the steward's department a receipt for the same, as having been received in good condition, and it is then, after a careful inspection, entered on the cards and placed in the bins.

In the chief's office are kept blue-prints of the entire house showing the exact location of all lights, telephones, fuses, valves, etc. Directly outside of his office door is placed a large blackboard which is divided into sections, each marked with the name of one of the departments under the chief's direction, such as steamfitter, plumber or electrician. Fastened at the top of each of these divisions is a hook such as is used for filing papers. A desk telephone is located at one side of the blackboard and upon this a clerk is in constant attendance. He receives the orders for repair work from different parts of the building and places them on duplicate blank forms, a copy of one of these being shown in Fig. 1. The original of this order is then placed on the hook of the department whose duty it will be to attend to the job. The duplicate of this order is retained on his file for reference. When the job is complete the original order is returned to the department where it supersedes the duplicate on the reference file.

After an order has been placed on one of the hooks it is removed by the first employe of that particular department who is out of work. He marks the location of the job on

REQUISITION.

Date Mar. 14/03 **Job No.** 31426

Time No. 412 **Signature** Chas. Murdock

1	6"	Fan
10'	#16	Flex. Lamp Cord
1		Socket Plug

Fig. 3. Specimen Requisition.

the blackboard, signs his name and the number of the order and goes about the job. In this way it is always possible for the chief to locate his men as well as the work upon which they are engaged.

A daily time card, such as is shown in Fig. 2, is made out by each of the workmen and turned over to the time clerk. This card shows exactly how the man's time has been employed throughout the day. When material is required on a job it is obtained by a requisition on the store room, a copy of one of these being shown in Fig. 3. These requisitions, when filled, are turned over to the cost clerk and, as no material is issued without a requisition, it is a simple matter for the cost clerk to charge the material together with the men's time to the correct piece of work.

In this connection it may be well to state that it is the duty of the cost clerk to distribute the costs of maintaining the engineer's department throughout the departments of the hotel. To accomplish this he makes use of large distribution

DISTRIBUTION.

Department Steward's.

Month March '03

Lights.	Ventilation.	Heating.	Plumbing.	Telephones.
	31426 12.00			

Fig. 4. Specimen Distribution Sheet.

sheets, the heading of one of which is shown in Fig. 4. These sheets are headed by the name of the department and are divided into double columns, each pair of which is marked with the different appliances which it is the duty of the engineer's department to keep in repair. In one of the divisions

of each column appear the job numbers and in the other the cost of labor and material used upon the respective jobs. A total is taken once a month from these sheets and to this is added a certain percentage of the cost of running engines, dynamos, batteries, etc., which are of general benefit to all departments of the hotel. From these distribution sheets a statement is made out in duplicate, the original going to the auditor's department and the duplicate to all of the departments.

The engineer's department is, of necessity, ready for business every day of the year, and for twenty-four hours of each day, although the night force maintained is as small as possible. While we have not gone into the details of the different methods to any great extent, still the foregoing shows that system in a large hotel as in any other line of business is necessary for running with a minimum loss and producing a maximum output.

* * *

SOME GERMAN OUTSIDE SPRING INDICATORS

DR. ALFRED GRADENWITZ.

The ever increasing pressures used in modern steam engine practice, as well as the successful use of superheated steam, are putting indicators under so severe a strain that any possible errors of design are magnified, and only the best can be used to advantage. Consequently inventors have of late years been examining the indicator critically with a view to a considerable change from the established design, and this point of view has resulted, both in the United States and Germany, in a number of patents for indicators having the spring on the outside of the cylinder.

Indicator investigators concentrated their attention to a great extent upon the piston spring, as the most vital part of the mechanism, and the one most subject to possible error. The sources of possible variation from correct results, in the use of the spring as calibrated, were thought to lie in a too great inertia of the moving parts, piston friction and lateral movement of the spring while being compressed, and changes in the scale of the spring due to its expansion or contraction under varying termperatures.

The "Staus" and "Willner" indicators, recently put on the market in Germany are thought by their inventor to have successfully eliminated these sources of error. The familiar Crosby spring was thought most suitable for these, as in it inertia and momentum are reduced to a low point, the small steel bead by which the spring is attached to the piston being the only mass moved by the wire in addition to its own. Also, the double coiling of this spring effectively counteracts any side thrust. The spring as used on the above-named indicators is seen in Figure 1 to differ from that used on the regular inside spring Crosby indicators only in being inverted, the steel bead being at the top, when the spring is placed on the piston rod instead of at the bottom.

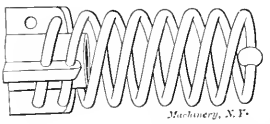


Fig. 1. The Crosby Indicator Spring.

While this spring is designed with a view to diminishing the influence of piston friction, etc., another factor to be considered is the change of the spring scale due to thermic expansion. As the temperature of the spring increases the spring expands, weakening it and lessening its scale; that is, instead of the pencil recording pressures of 40 pounds to the inch of ordinate, for example, the true reading would be perhaps only 39 pounds. This influence cannot be allowed for entirely by calculation, as the temperature of the spring in inside spring indicators is dependent on several variable factors, as the tightness of the piston, the length of time during which the cock is open, etc. Experiments made in Germany are said to have shown that in inside spring indicators departures up to 6 per cent. in the readings have occurred between tests made in the cold or the warm state.

The effect of residual elasticity is much more strongly felt with elevated temperatures than with low. Those who advance the claims of the outside spring indicator believe that by the position of the spring characteristic of that instrument the range of suddenly changing temperature to which the spring is subjected is greatly decreased and with it an important cause of inaccuracy. They also call attention to the rusting effect of the steam or gas to which inside springs are exposed.

The Staus indicator, as shown in Figure 3, is arranged as follows: On the cylinder cover are two steel columns connected above by the spring support and held at the bottom by a nut. The spring is screwed to the support and is acted upon centrally by the contiuation of the hollow piston rod. The ball at the top of the spring has its bearing in a slit at the end of the piston rod, where it is locked by a milled screw. The recording outfit is similar to the one used in the Crosby indicator (ratio 1 to 6), the pencil lever passing around the piston rod symmetrically with a yoke construction so as to prevent any side thrust. The piston with its spring and recording mechanism may be removed as a whole, without being unmounted, upon loosening one nut. The spring may be easily exchanged for another by removing a screw. The height of the atmospheric line on the paper can be varied at will by inserting supporting disks between the head of the spring and its support. According to experiments carried out in Germany, the spring remains cool during the use of the indicator both with saturated and superheated steam.

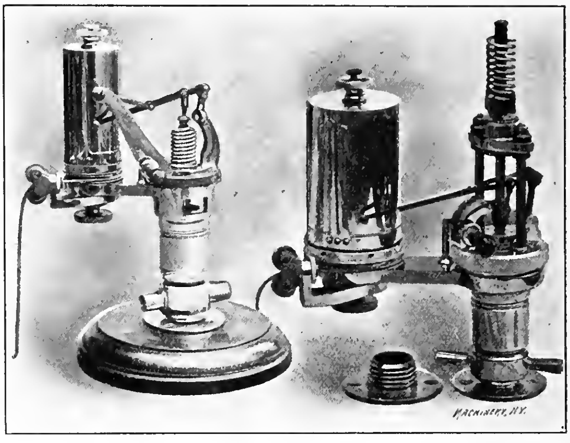


Fig. 2. The Willner Indicator. Fig. 3. The Staus Indicator.

Another outside spring indicator based on a similar principle is the "Willner" indicator, represented in Fig. 2. This is suitable for use on engines of higher angular speed than the Staus indicator, as the weight of its moving parts is lower. It is claimed that this indicator works satisfactorily up to 800 turns per minute, while the Staus indicator is suitable for 300 to 350 revolutions.

The details of construction of the Willner instrument will be seen from Fig. 2. Because of the large spaces provided, as shown for the passage of the outside air below the insulating indicator cover, the spring is said to take a temperature no higher than that of the hand even after prolonged service.

The patented instruments described above are being brought out by their inventor, Mr. H. Maihak, of Hamburg, Germany.

* * *

Pening, riveting, calking, and battering are terms that mean very much the same thing to the lay mind, but there is, of course, a great difference. For example, the difference between pening and battering a piece may be expressed by saying that pening is a systematic striking of the work with the pene of a hammer, so as to cause the metal to flow into a regular shape, and battering may be the same work unskillfully done, the blows being delivered with either part of the hammer, the pene or face, as it may happen, and struck unsystematically over the work as an unskilled workman may direct. Pening may be the same as riveting, as when the end of a pipe is pressed over to fill a groove bored in the face of the flange. Calking and pening may be the same operation, but ordinarily calking requires the use of an intermediate tool between the hammer and the work.

HARD LINES FOR DRAFTSMEN.

H. E. WOOD.

Don't make uneven lines.
Don't fail to take notes.
Don't make pale blueprints.
Don't upset your ink bottle.
Don't roll a drawing too tight.
Don't fail to trim each tracing.
Don't use a ruling pen that cuts.
Don't go to sleep over your work.
Don't worry; it injures your work.
Don't fold tracings; it injures them.
Don't make a dirty looking drawing.
Don't make figures out of proportion.
Don't make a mistake adding fractions.
Don't work on wrong side of the paper.
Don't fail to pick up "dropped tacks."
Don't try to work with a blunt pencil.
Don't put the wrong number on a drawing.
Don't give two drawings the same number.
Don't take orders over your chief's head.
Don't be reluctant about making sketches.
Don't put your pens away with ink in them.
Don't waste material; it is very expensive.
Don't take orders from anyone but the chief.
Don't leave tacks, point upward on a board.
Don't leave out important lines on a drawing.
Don't keep your tracing cloth in a damp place.
Don't give out a drawing until it is complete.
Don't use instruments with lost motion in them.
Don't be backward about taking responsibility.
Don't make center lines heavier than main lines.
Don't make unnecessary tack holes in a drawing.
Don't draw a line unless you know what it is for.
Don't be "earless"; it may land you in the street.
Don't pull out thumbtacks with your finger nails.
Don't hold your instruments in an awkward position.
Don't crowd the different views; it shows bad taste.
Don't cover a drawing with unnecessary measurements.
Don't get angry if you are asked to change a drawing.
Don't be thoughtless, or you won't be very successful.
Don't punch your scale full of holes with the dividers.
Don't fail to give every detail necessary consideration.
Don't let tracing cloth get wet, for then it is spoiled.
Don't keep a lot of unnecessary drawings laying around.
Don't forget that it is bad practice to do too much erasing.
Don't lose sight of the fact that sections are very important.
Don't put measurements on a drawing in an improper manner.

Don't try to do the chief's work, until you can master your own.

Don't leave your mistakes for others to find; find them yourself.

Don't ask unnecessary questions of the chief; reason them out yourself.

Don't fail to consider the convenience of the machinist whenever possible.

Don't make the lines too faint on a tracing, for they make poor blueprints.

Don't make a drawing unless you can see in your mind just what the piece looks like.

Don't put a measurement on a drawing that won't make up to correspond with the total.

Don't tear up sketches as soon as the drawing is made; they serve as proofs, sometimes.

Don't forget to use round-point pencils for figures and letters, and flat points for lines.

Don't forget that the patternmaker should be considered sometimes, for he has to work to your drawings.

Don't put figures on a drawing unless you know what the consequences will be when some one else works to them.

Don't forget that the machinist will always try to blame the draftsman for his own mistakes if he possibly can do so.

Don't fail to be prepared with reference data for proportions, etc., such as are found in MACHINERY data sheets.

Don't forget that a mechanical draftsman should also be a machinist, and have a first-class idea of foundry, pattern, and blacksmith shop work.

Don't forget that the point of a draftsman's pencil is the turning and starting point of many long roads; so be careful how you handle it.

Don't fail, when dimensioning a drawing to go into the machine shop, to give all measurements as far as possible, from some main or general surface, as it is easier for the machinist to work from.

* * *

A SET OF ACCURATE TEST AND INSPECTION GAGES FOR SMALL DUPLICATE WORK.

JOSEPH V. WOODWORTH

In Figs. 3, 4, 5, and 6, is illustrated a set of four tests and inspection gages of interesting design, possessing adaptable features which may be used to advantage in similar gages for verifying measurements of small, accurately machined steel parts. All four of the gages are graduated to indicate variations down to .0005 inch.

The work for which the inspection tools were utilized consisted of two parts of tool steel, which were machined to

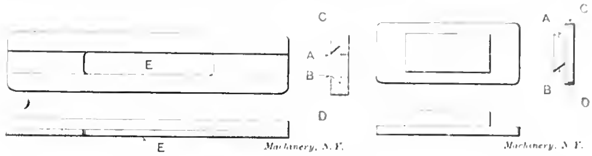


Fig 1 The Pieces to be Gaged. Fig. 2

extremely accurate dimensions, and were required to fit or assemble together perfectly. These two parts are illustrated in Figs. 1 and 2. The part shown in Fig. 1, as may be seen, has a dovetailed channel milled in one side for its entire length, and has the web punched out to form a hole at *E*. This part, after all milling operations had been concluded, was hardened and tempered; the temper being drawn down sufficiently low to allow shaving the dovetailed surfaces to finish sizes with "Novo" steel cutting tools, after which the sides and edges of the part were ground to limit sizes with a cup shaped emery wheel in a specially constructed grinder. It was after this operation, that the two gages illustrated in Figs. 3 and 4, were used to determine the degree of interchangeability attained in the parts through the various concluding mechanical operations.

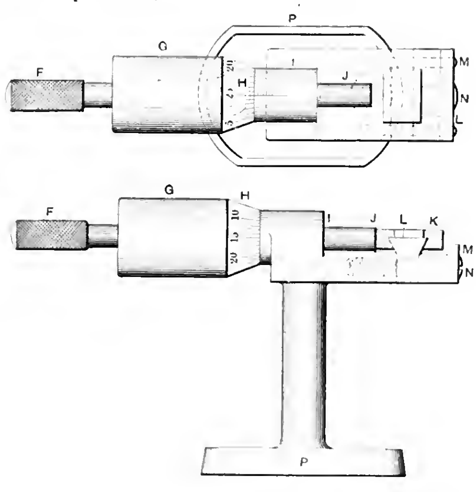


Fig. 3. Micrometer Gage for Thickness of Side of Fig 1.

The micrometer gage shown in Fig. 3, was used to determine the width of the part from the dovetail to the edges, as is indicated in the lower view, in which is shown a cross section of the work in position on the dovetail locating piece *L*. After gaging one side, in the manner outlined, the other side is inspected by simply reversing the work on the dovetail locator. The drawing of the gage is so clear and self-explanatory that a detailed description of construction will be un-

necessary. F, G, H, I and J comprise the micrometer portions, L is the locater, M is the block upon which it is formed, N the fastening screw and dowels which fasten and locate it in position on the body of the gage, P is the base and O the stem of the gage. Two flathead screws were used to fasten the gage to the work bench. All locating and test parts of the gage were hardened and carefully ground and lapped.

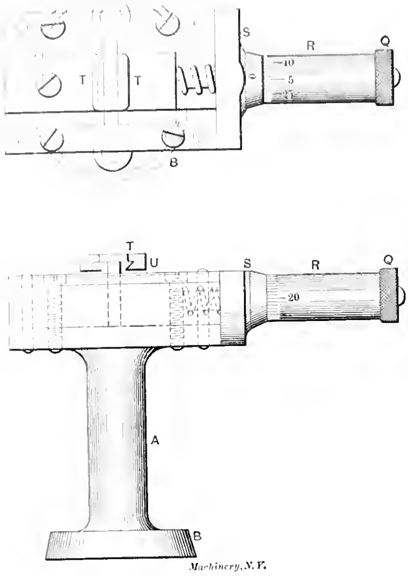


Fig. 4. Micrometer Gage for Width of Channel of Fig. 1.

The micrometer gage illustrated in Fig. 4, was used for measuring the width of the dovetail channel in Fig 1; that is, the distance between points *A* and *B*. This gage consists of base *B*, which is fastened to the work bench when in use, stem *A*, two slides *T T*, which have raised angular faced projections which conform to the angle of the dovetail in the work, and the micrometer portions *S*, *R* and *Q*. The manner in which the gage is used to determine the width of the dovetail is clearly indicated in the lower view of Fig. 4, a cross section of the work being shown in position. By revolving the barrel, by means of the knurled end *Q*, the slide *T*, at the right, moves back, to allow removing or locating the work; while the revolving of the barrel in the opposite direction causes the slide *T* to move out and expand to the full width of the dovetail channel in the work. The other slide, *T*, is fixed. A light, spiral spring, which is shown in the plan of Fig. 4, assists the slide to move back readily when the barrel is revolved and the work is to be removed or located.

It will be noticed that both gages described in the foregoing, are simple in design and of comparatively inexpensive construction, when the rapidity with which the work may be handled and inspected in them, and the required accuracy of the tests, are considered. In case of wear, in any of the precision parts of either gage, the error may be rectified by simply making suitable adjustments, provision for which may be seen in the drawings; thus no difficulty is experienced in maintaining the accuracy of the tools.

In Fig. 2 is shown the dovetail slide which is required to assemble on the part shown in Fig. 1. This piece is also made of tool steel, is accurately machined all over, shaved on the dovetail surfaces, *A* and *B*, and then ground on the back. It was for verifying the interchangeability of this part that the decimally graduated inspection gages shown in Figs. 5 and 6, were used for determining the exact amount of variation in the parts from the inner edge of the dovetail, *A* and *B*, to the ground edges of the body portion at *C* and *D*.

The gage consists of a flat cast iron base, *F* cored at *G* and equipped with four steel legs, *K K K K*. *W W* is the test and gage portion proper, and consists of a dovetail piece of tool steel which is fitted and gibbed into a channel in *F*, as shown, by gib *P* and screws, *O O*. This piece is milled away in the center so as to provide a clearance way for the pointer *J*, which is pivoted on a small pin at *N*. The projecting end *Q* of *W* is hardened, ground, and lapped to conform to the angle of the shaved dovetail surfaces of piece Fig. 4; it is also drilled longitudinally in the center of *Q*, to accomodate the plunger, *R*, which is fitted to "float" in the reamed hole. The rounded end of *R* at *S* rests against the edge of the pointer. Pin *T* in the end of the plunger prevents it from getting away, and the light spring *M*, serves to keep the plunger out when the work is not against it. Knurled head screw *U*, spanned by yoke *V*, and screwed into *F*, is utilized to correct any inaccuracies in the precision parts which occur through use and wear. The graduations for reading the tests are at *I*, at the extreme end of *F*, with the end *J*, of the pointer matching them. When the pointer registers at *O*, the work is up to the requirements; if it points to 5 at the left the work is considerably too large; if it points to 5 on the right the work is too small.

In using the gage it is placed on the bench before the inspector and the dovetail slide Fig. 2 is located on it with one dovetail edge resting against the angular face of *Q*, and the edge *D* resting against plunger *R*; thus, upon the inspector pressing down and in upon the work the edge forces the plunger *R* inward, and therefore causes the pointer to register the reading at *I*. A spanner of small diameter drill rod at *H H*, acts as a guard for the pointer.

In Fig. 7 we have another decimally graduated test gage, used in the inspection of part Fig. 2. It is used to determine the exact width of the dovetail portion, from *A* to *B*. A base of cast iron is machined to accomodate the hardened and ground angular faced pieces *I* and *F*. Piece *I* is fastened and

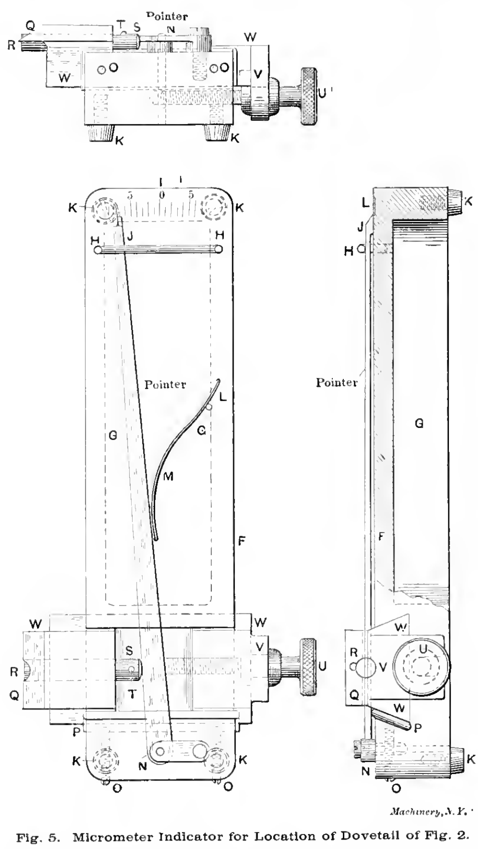


Fig. 5. Micrometer Indicator for Location of Dovetail of Fig. 2.

located by screws *KK* and *JJ*, while piece F is left free to slide in the holder. It will be noticed in the plan view of this gage that the dovetail edges *G* and *H* of *I* and *E* respectively are at an angle of a few degrees with the dovetailed channel in the base; thus as the slide *F* is pushed forward the space between *G* and *H* decreases; and as it is pulled back in the opposite direction the space increases; therefore by simply en-

tering the work so that the dovetail part rests between G and H and then pushing the slide forward until the work is clamped or held tightly, a reading may be had instantly by noting the relation of the graduated line with zero point O at P.

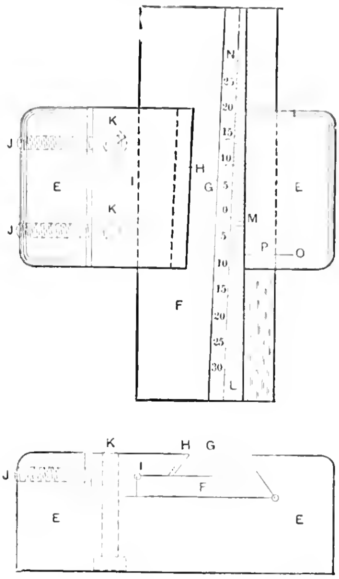


Fig. 6. Micrometer Gage for Dovetail of Fig. 2.

Although gages of the types described in the foregoing may appear quite simple and easy to construct, considerable skill and care are necessary in the grinding, lapping and graduating, in order to produce reliable precision instruments for the inspection of accurate work.

* * *

RELIEF OF TAPS.

H. D.

In the manufacture of taps one of the most particular and serious questions arising is how to give a proper relief to different kinds of taps. Any one familiar with the making of taps knows, of course, that a hand tap should be given a different relief than, for instance, a pipe tap. For this reason the different kinds mostly used have been treated separately, each kind by itself.

Hand Taps.

The old, and up to some time ago universally used way, was to give all the teeth a relief in the angle of the thread, *i. e.*, the heels of the teeth were made of smaller diameter than the diameter measured over the cutting edges (as shown in the end view of Fig. 2). However, this has been found to be wholly unnecessary, and taps of this kind are now made without any relief whatsoever in the angle of the thread, but the top of the thread of the *chamfered part only* is slightly relieved. To further improve upon the cutting qualities of the tap, it should be made smaller in diameter toward the shank than at the point. This difference in diameter should of

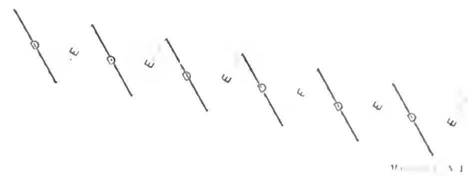


Fig. 3. Section of Cutting Edge of Taper Tap.

course, vary for different diameters, and the limits in variation of size permitted must, of course, also be taken into consideration. It may be said that in general practice it is answering the purpose if the tap is about 0.0015 inch smaller at the shank end of the thread for taps up to ½ inch diameter, and from 0.002 to 0.003 inch smaller at this end than at the point for taps from ½ up to 2 inches diameter. It may be added that although this is an essentially good point in tap making, most manufacturers do not make their taps that way, probably because it would increase the expense in the manufacture, and require greater care in making.

Another improvement upon a hand tap, seldom seen in taps manufactured for the market, is to give to the angle of the thread a relief in the center of the land, as is shown in Fig. 1. The reason for so doing is obvious. The tap gets the same support along its periphery as if not relieved in the angle of the thread, because it retains its bearing at the heel of the thread, but as can be clearly seen a good portion of the friction is eliminated.

Taper Taps.

In order to fully explain what is referred to as a taper tap in the following, it may be well to say that such a tap has the part of the thread nearest the shank larger in diameter than at the point of the tap, as, for instance, a pipe tap. This is mentioned on account of the fact that the first tap in a set of hand taps is commonly, but not properly, referred to as a "taper tap," and it would perhaps cause confusion if special attention was not called to the correct meaning of the term "taper tap."

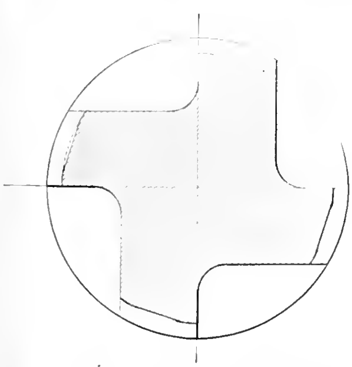


Fig. 1. Relief of Land for Straight Tap

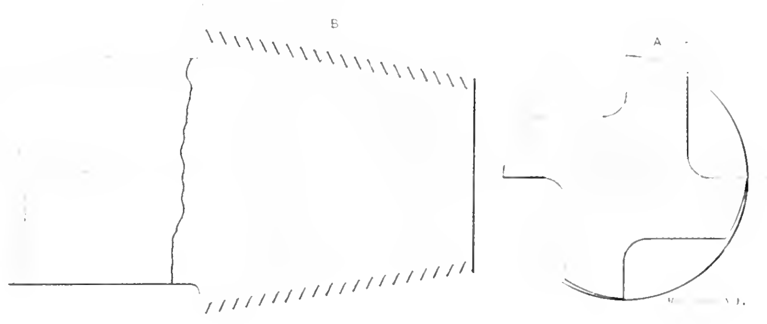


Fig. 2. Relief for Taper Tap

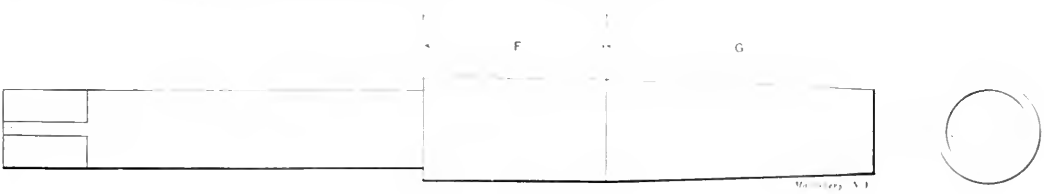


Fig. 4. Machine Tap.

It is obvious to any one considering the matter that a taper tap (Fig. 2), relieved in the same manner as a hand tap described, would refuse to cut altogether. A tap of this kind should invariably be given a relief the entire width of the tooth *A*, and the full length of the thread *B*. It is also to be noted that the greater part of the relief should be given on the side *D* of the thread, to lessen the friction and the resistance while cutting (see Fig. 3). That such a result will be obtained will be perceived after a careful consideration, because the pressure on the thread of the tap that is created by the cutting process will all come on this side of the thread, and if then relieved properly so as to only permit the *cutting edge* to come in contact with the material to be cut, it is obvious that the friction is reduced to the smallest possible amount, at the same time as the keenness of the cutting edge is increased.

Machine Taps.

Under this heading are treated taps used for threading nuts in special nut-tapping machines. Such taps are subjected to very hard usage, and must therefore be made in a special way, and with special care.

A tap of this kind has a part, *G*, tapered on the outside of the thread, and a straight part, *F*, as will be seen from the cut. The length of the tapered part should depend upon the material the tap is to be used upon, and also upon the length of the nut to be tapped (the longer the nut, the longer the part of the tap tapered on the outside should be). This part, *G*, ought to be relieved both at the top and in the angle of the thread, *i.e.*, the diameter measured over the heel should be smaller than the diameter measured over the cutting edge.

The straight part, being nothing but the sizing part of the tap, should be left without relief, or if any should be given, it ought to be very slight, so as to permit the tap to retain its size all the longer.

Ordinary die taps can also be made in the same way as a machine tap.

Hob Taps.

As these are generally used for "burring" and sizing, and have little or no cutting to do, they are mostly made with no relief at all. An exception from this might be made in making a taper hob tap which might be slightly relieved on the same side of the angle of the thread as is shown at *D* in Fig. 3.

* * *

VISITING SHOPS.

ENTROPY.

What a variety of people wander into a shop in the course of time. We get all kinds from the proprietor of the big shop over in town down to the pretty young misses who come in to see the wheels go round, and who go away wondering why they cover up all the new castings with dirt, and why men who just stand and watch a machine go don't dress like bank clerks. Once in a while a few of the "Tech" boys come in who watch us cutting a pinion for a while and then call to another fellow to come over and see us fluting a reamer. Their professors also come once in a while, and they are more fun than the boys in exactly the proportion that they try to be more serious. It often occurs to me that it is a really wonderful thing that a college or technical man ever succeeds in bucking the world at all after being mewed up for years with instructors whose ideas of what is going on in the world are as vague as those that we see here. I suppose, though, that if a boy has brain and vitality enough to go through a technical course he is capable of almost anything when he gets out and has a chance.

Then, there is the new agent on the road, selling paint or oil or some other thing distantly related to the trade. He adds to our fund of humor by selling us white asphalt, four-sided three-square files and other novelties passed down from Noah, but leaves us without adding to our store of knowledge.

Next is our friend who advises us what machine tools to buy and clings to us till he gets his commission, unless in the meantime he gets to criticising our pet equipment; then we turn him down like a lump of lead. Why, I have known of a large and prominent firm turning down an equally important make of turret lathe simply because the builders of the latter advised making a certain simple piece in a reverse order from what their superintendent had been in the habit of doing. But isn't it curious what instincts different occupations develop? Did you ever see a blacksmith that didn't scowl? He gets it looking at the fire and carries it home and passes it along. Did you ever see a lawyer or a teacher that wouldn't criticise anything and everything just for the sake of hearing himself knocking? It's part of their business. If they for a moment should forget themselves and pat some one on the back and call him a good fellow, where would their jobs be? Did you ever see an old salesman who was narrow or bigoted? They couldn't stay on the road if they were; they either have to reform or drop it. Daily and hourly intercourse with men who have dug out fortunes from the cold side of the world puts a man where he can appreciate the good that men do and where he can see something of the relative value of the ten commandments, and while the traveling man may have his own favorite vices, he will average more real men to the thousand than most of those who run him down.

Most shop owners, or the men who run shops, are like a lecturer, or a minister, or an actor—they like to see people who are interested in what they are doing and who are willing to make their interest manifest. Every one of them either has ideas of his own or else is getting out of business as fast as he can, so you don't want to see his shop. These shop men are all looking out for ideas, but an idea is like a trout; you want to fight for it and catch it yourself. So don't go visiting shops and handing out your ideas of how they should be run the same day. Remember that advice is usually worth what it costs, and if you have any to spare store it for a rising market. And remember, too, that comparisons are odious, and don't tell him how some one else does. He may be too polite to tell you that the other fellow is a back number, or he may get on his ear, as I did once. One of our neighbors came in and looked at some lathe aprons we were building. He remarked in a disdainful tone that he didn't build them that way. To which I replied that I knew he didn't, because he built his exactly like R———'s, and I had always wondered which one stole it!

If you want to get in your man's best graces, look around and comment favorably on something that he has not pointed out; then you are sure to see everything that he can show you, and he will send you away with a "pleased-to-have-met-you" smile that will last clear home. Visiting shops is an art in itself, and the chief art of it is to get in the good graces of the man who is showing you around. You will inevitably get some wrong impression, so don't tell anything unfavorable of a shop to any one before making at least a second visit. A frank avowal of your business and of what you wish to see is a better introduction than all the letters you can carry, for the vast majority of shop men are used to judging others, and they like the tub that stands on its own bottom.

* * *

A description of an ice-making plant which recently appeared in a daily paper, contains the following statement: "Ice made in this plant has good lasting and refrigerating powers." At first thought this remark looks somewhat peculiar, since we are naturally inclined to believe that ice is ice, whether it be chopped from an iceberg or made in a refrigerating plant. There is some basis, however, for making a difference between the lasting qualities of artificial and natural ice, although the newspaper reporter may not have understood just what that basis is. When ice is made under the can system, the freezing of the water leaves a spongy core in the center of the cake. This means that, as compared with a block of solid ice of the same dimensions, the superficial area will be the same, while the weight of the artificial block will be less, so that for a given weight the latter form of ice will melt more rapidly. As to its "refrigerating qualities," it will probably take the same number of heat units to melt a pound of ice under the same conditions, no matter how it was frozen. The ice plant referred to is one erected recently at Niagara Falls, in which electric power is used exclusively. The water is frozen in large tanks, thus avoiding the spongy core referred to above.

CONDENSING PLANTS FOR HIGH VACUUMS.—1.

The main hindrance to the realization of the many claims for the steam turbine appears to be the condensing system with which it must be equipped to produce the best results that the turbine is capable of. The turbine by itself is simple, apparently is durable, economical of steam, and requires but little attendance. Add to the turbine, however, a condensing plant consisting of a surface condenser large enough to allow a vacuum of 28 or 29 inches, an air cooler attached to the condenser, a circulating pump large enough to handle twice or more the usual quantity of cooling water, wet and dry vacuum pumps, the latter being a compound or two-stage pump in some cases, and the engines or motors to drive this apparatus, and one has a really formidable steam plant. These various auxiliaries must be maintained at the highest state of efficiency and all joints kept tight to avoid leaks. The condensing apparatus in turbine plants has generally given more trouble, required more attention, and has been a greater source of expense than the turbine itself, and in spite of the fact that the latter is a new type of apparatus which cannot be considered to have been perfected. These difficulties, however, have often been due to lack of careful lay out of plant and will grow less with the more general substitution of motors for reciprocating engines and of rotary for reciprocating pumps for the auxiliaries.

The reason why it is so important to have an elaborate condensing plant is that the turbine is capable of taking full advantage of high vacuum, by expanding the steam down to the lowest pressure that can be attained in a condenser, thus making use of the heat energy represented by this difference of pressure. In a turbine there is no restriction to the number of times that steam may be expanded, except that the passages must be large enough to accommodate the increased volume of the steam at the low pressures.

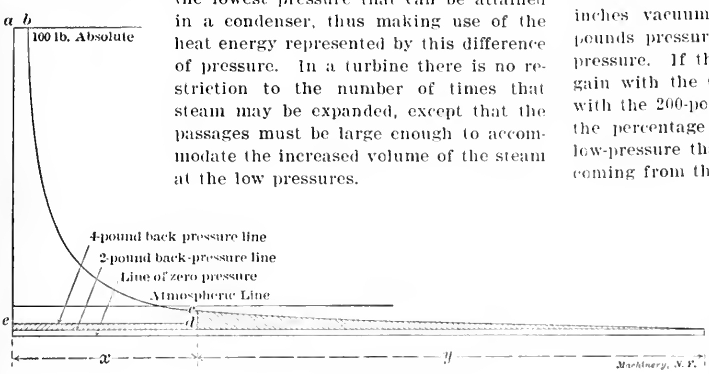


Fig. 1.

In a steam engine the gain from increasing the vacuum above 26 inches is so slight as not to warrant the extra expense of the large condensing apparatus required. A compound engine with the usual cylinder ratio of 4 to 1 will expand the steam from ten to fifteen times. The volume of one pound of steam at 150 pounds pressure, absolute, is 3 cubic feet. In expanding 15 times, or to a volume of 45 cubic feet, the terminal pressure in the low-pressure cylinder would be between 8 and 9 pounds, assuming cylinder condensation to be balanced by re-evaporation. When the exhaust valves open, therefore, the pressure would drop to that of the condenser, and the only effect of a vacuum higher than that represented by the eight or nine pounds pressure in the cylinder is to reduce the back pressure against the piston during the return stroke.

In high-ratio compound engines, having a cylinder ratio of about 7 to 1, steam is expanded 20 or 25 times and more heat energy is theoretically converted into mechanical work than in the previous case, which would make the engine more efficient were it not that the losses from condensation and friction are enough greater to nearly or quite balance whatever gain there may be. If the attempt is made to carry expansion too far in a steam engine, the low-pressure cylinder, valves and passages must be abnormally large and will offer a great deal of frictional resistance. It will be evident that under such conditions a point will be reached in the low-pressure cylinder where the pressure of the steam will not be sufficient to overcome the frictional resistances, to say nothing of doing useful work, and the expansion of the steam beyond this point will therefore be a dead loss and the engine, instead of giving up power, will require power to drive it.

Table I. gives the volume of one pound of steam corresponding to different "vacuum" pressures and indicates how impossible it is to utilize these low pressures in the steam engine.

TABLE I.

Absolute Pressure.	Vacuum, Inches.	Specific Volume.
½	29	636
1	28	335
2	26	171
3	24	118
4	22	90

To expand steam from 150 pounds to 1 pound absolute, or to 28 inches vacuum, would mean that the volume must increase 111 times. To carry the expansion to this point in a compound engine, the ratio of the cylinders would have to be about 33 to 1; that is, the diameter of the low-pressure cylinder would be 10½ times that of the high-pressure cylinder—quite an impracticable figure.

The steam turbine, on the other hand, needs all the expansion that can be given the steam, and is able to derive full benefit from it. An idea of what the gain is from the use of a high vacuum can be obtained by referring to a few calculations. Konrad Anderson, in a paper upon steam turbines in the Transactions of the Institute of Engineers and Shipbuilders of Scotland, 1902, compares power values for steam expanding from 60 and 200 pounds, respectively, and finds that the theoretical gain in running condensing, with 25 inches vacuum, is nearly 100 per cent with steam at 60 pounds pressure, and 50 per cent with steam at 200 pounds pressure. If the vacuum be then increased to 28 inches, the gain with the 60-pound steam will be about 22 per cent and with the 200-pound steam about 18 per cent. This shows that the percentage gain from running condensing is more with low-pressure than with high-pressure steam and that the gain coming from the last few inches of vacuum is relatively much more than from the first few inches.

This latter fact has been brought out in a striking manner by Ernest N. Janson in an article upon steam turbines in the *Journal of the American Society of Naval Engineers*, 1903. He shows that with the initial and terminal pressures in the same ratio, the kinetic energy of the steam in flowing from a higher to a lower pressure is nearly the same, without regard to what the initial pressure is. For example, supposing the initial pressure to be 105 pounds and steam to expand to one-third this pressure, or to 35 pounds, he finds the kinetic energy developed by the steam to be only 10 per cent more than when expanding from 3 pounds to 1 pound. The figures are as follows:

$\frac{p_1}{p_2} = \frac{105}{35} = 3$; velocity $= 2{,}050$ ft. per sec.; H. P. per lb. of steam per hour $= 0.033$.

$\frac{p_1}{p_2} = \frac{15}{5} = 3$; velocity $= 1{,}933$ ft. per sec.; H. P. per lb. of steam per hour $= 0.029$.

$\frac{p_1}{p_2} = \frac{3}{1} = 3$; velocity $= 1{,}790$ ft. per sec.; H. P. per lb. of steam per hour $= 0.025$.

Fig. 1 illustrates the expansion of one pound of steam from an initial pressure of 100 pounds to the pressures indicated, and illustrates the difference between the way in which an engine and a turbine are able to benefit from a high vacuum. It shows the work done both before and during expansion, as in an indicator diagram. The section of the diagram marked *a-b-c-d-e* represents that part of the energy of the steam that might be converted into work by a condensing engine operating against a back pressure of four pounds, or a vacuum of about 22 inches. When the exhaust valve opens, the pressure drops from point *c* to point *d*. If the vacuum were increased to 26 inches, the gain in power would be due simply to the reduction in back pressure represented by the shaded portion

having the length x on the diagram. This, it will be noticed, is but a small percentage of the total area of the diagram. In the turbine, however, it is different, since expansion can be carried to the 26-inch vacuum pressure within the turbine itself. The turbine is able to utilize the toe of the diagram, indicated by the shaded portion y, in addition to shaded portion x, while the engine is unable to turn to any account the energy represented by the toe of the diagram.

In Fig. 2 are shown the essential features of a turbine condensing apparatus as built by The Henry R. Worthington Co., of the International Steam Pump Co. Steam enters at the top of the condenser, and is distributed over the tube surface by baffle plates, while the condensed steam drops down into the hot well at the bottom, where it is discharged by a rotary pump. This pump requires neither valves nor floats, and is not subject to vapor binding, as are reciprocating pumps. The capacity of the pump is such that it runs ahead of the supply, so that the suction pipe is never full; but the discharge pipe is always full, and the water presses back against the pump; but as long as the latter is in motion it cannot pass back into the condenser.

The air is removed by a rotative vacuum pump which connects with an air cooler or auxiliary condenser. The vapor and air from the condenser passes through this air cooler, through the tubes of which cooling water circulates, and the temperature and specific volume of the air and vapor are

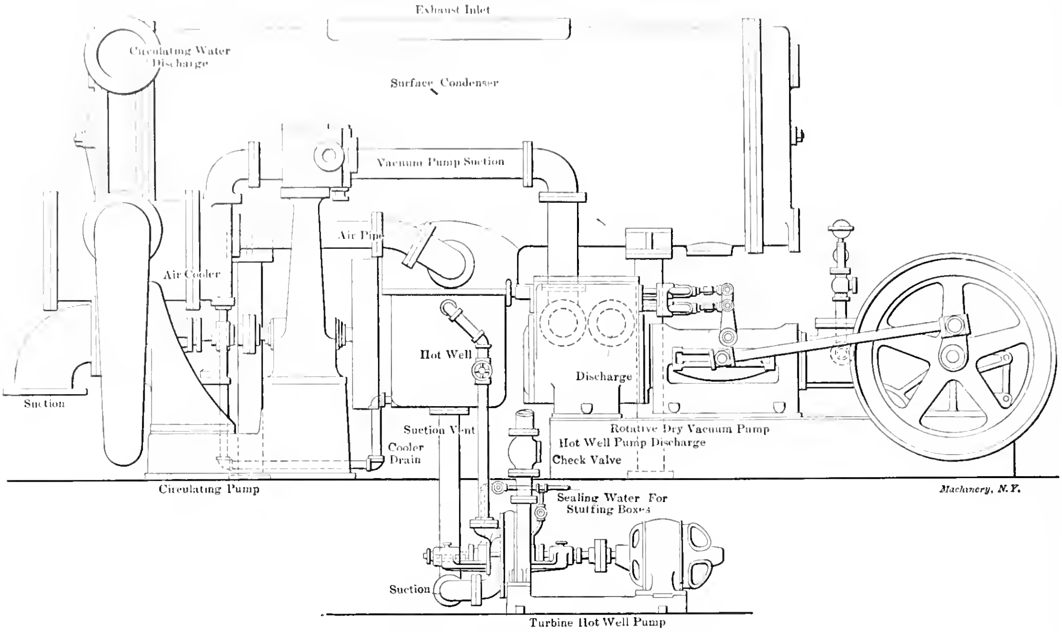
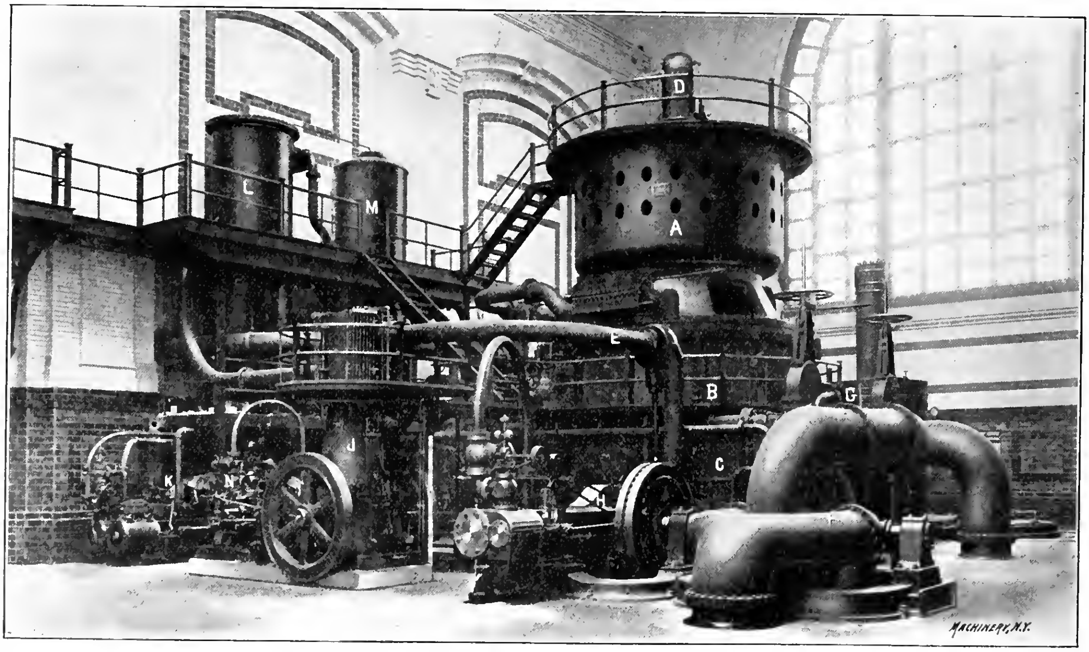


Fig. 2. Typical Arrangement of Worthington Apparatus, with Air Cooler and Wet and Dry Vacuum Pumps.



A.—Generator.
B.—Turbine.
C.—Condenser.
D.—Governor.
E.—Steam Nozzles.
F.—Circulating Pump.
G.—Accumulator.
H.—Engine driving Circulating Pump.
J.—Vacum Pump.
K.—Boiler Feed Pump.
L.—Oil Tank.
M.—Feed Water Heater.

FIG. 3. 500 K. W. CURTIS TURBINE AND AUXILIARIES.

thereby reduced, which enables the vacuum pump to maintain a better vacuum. A rotary circulating pump driven by motor or engine is used for the cooling water.

Fig. 3 is from a photograph of a 5,000-kilowatt Curtis turbine and condensing apparatus installed at the new station of the Edison Electric Illuminating Co., Boston, Mass. In this case, the condenser is built into the base of the turbine, and forms a part of the unit, while the auxiliaries are placed on the same floor level as the turbine itself, where they are employed, one cylinder of which draws the air or vapor from the condenser and delivers it to the other cylinder, which in turn forces it out against the pressure of the atmosphere. Space is saved and the apparatus simplified in this installation by using the same engine to drive both the circulating pump and the vacuum pump, and it will be noted that the condenser and its pumps require just about the same area as the turbine itself, while, by setting the condensing apparatus in a pit, it rises only to the top of the turbine.

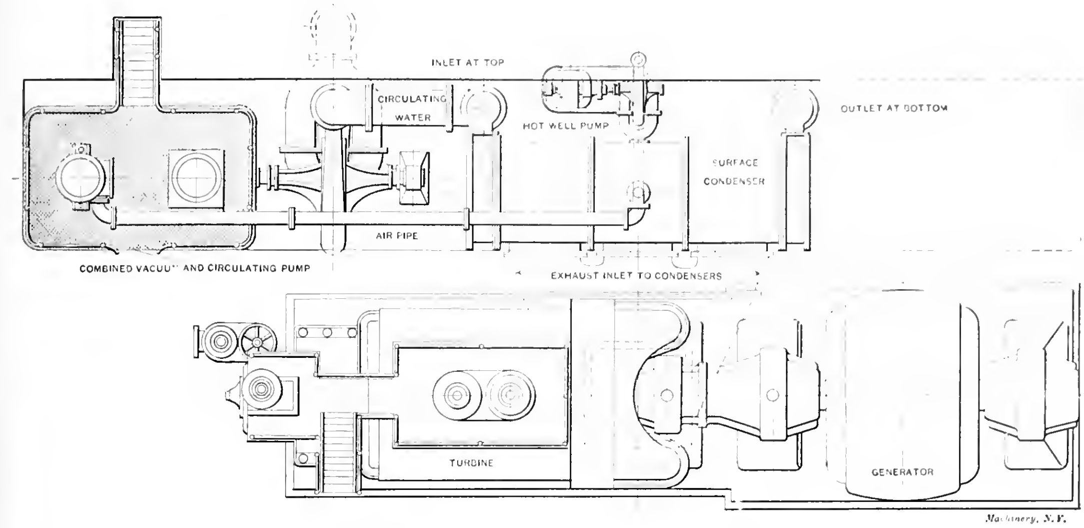


Fig. 4. Plan View of Parsons Turbine and Alberger Condeneer and Auxiliaries.

more accessible. This illustration gives an excellent idea of the quantity of apparatus required to keep the plant in operation, since the feed pumps, heater, oil tank, and accumulator for supplying the hydraulic pressure that must be maintained under the step bearing of the turbine, etc., are all grouped about the turbine, in addition to the condenser auxiliaries.

In Fig. 4 is a plan view of an Alberger surface condenser and apparatus designed to be applied to a 5,000-kilowatt Parsons turbine. The Alberger condenser is a counter-current

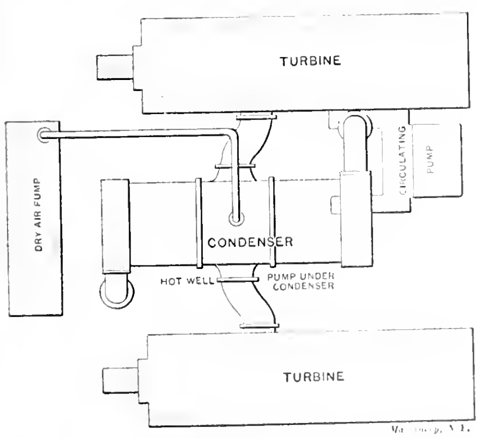


Fig. 5. Arrangement for a Central Condenser with two Turbines.

condenser, and does not require the use of a separate air cooler. The exhaust enters at the bottom and passes upward over the tubes. The cooling water enters at the top and passes downward, back and forth through the tubes. The air and vapors rising to the top of the condenser are therefore cooled by the incoming cold water and the condensed steam which trickles down into the hot well comes in contact with the surfaces cooled by the warm water as it leaves the condenser, and it is thus possible to maintain a high hot-well temperature without difficulty. A two-stage vacuum pump is

Where more than one turbine is installed in a station, space may be saved by using one large condenser for two or more turbines. Fig. 5 is a plan in outline indicating the relative area occupied by two 400-kilowatt Parsons turbines, with one condenser placed between them. This plan can even be extended further and a central condensing system employed for several turbines, similar to the condensing plants now used in many of the large power stations; but it has the objection of possible leaks in the long pipe connections required.

* * *

A PLEA FOR BETTER SURROUNDINGS IN THE FOUNDRY.

One great drawback to success in obtaining young men of high standard for our foundries is the environment of the foundry itself, known as it is to most people as a dingy, dirty, smutty, smoky old place to work in with poorly lighted and ventilated buildings. No wonder in many cases the best boys do not take as kindly to the trade as to some other calling. It becomes necessary then for us to give all these matters more attention, to devise ways of bettering the conditions of the very places in which we expect our men to perform their daily task. I do not wish to be understood as advocating a rank waste of money in providing expensive buildings, equipped with lavatories, with the latest design of shower baths, individual wash bowls with soap cake, Turkish towels, elaborate dining rooms, etc., but I do wish to say that in my judgment it is possible for any foundryman to provide a suitable place for his men to hang their coats and deposit their dinner pails upon entering the shop; that such a place be so arranged as to insure neatness and cleanliness, as well as a suitable place for the workmen to warm their coffee at noon, and a small, well-kept room for them to gather in in cold weather and eat their noon meal in comfort. As an attraction for the best quality of boys, it will be found that a well-lighted shop beats darkness; that a neat and well-appointed locker is superior to the peg in any old post for the coat; that a comfortable place for dinner is ahead of the sand pit; that conveniently-located, well-kept closets surpass the back yard, and that a suitable place to wash up at the shop is more attractive to high grade boys than carrying home the day's accumulation of sand and dirt to perfume the home and vex the family.—*O. P. Briggs in American Industries.*

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Attention is called to the paragraph headed "Caution" on page 107 of the Engineering Edition, and page 67 of the Shop Edition.

* * *

A subject upon which more data could profitably be published is that of the cost of machine work. The article recently published in our columns upon "Estimating the Cost of Machine Work," by J. A. Webster, has attracted considerable attention, but it deals with only one machine, and that a very small one. We should like, for example, data upon different classes of work, with an explanation of the methods followed in estimating the cost of such work. Take the case of the screw-machine. How do you estimate the time for screw-machine work? What allowance do you make for setting up, for the actual cutting of the stock, for the rotation of the turret, etc.? To what make of machine do these figures apply? Can you give data upon actual pieces that have been made? The same kind of information could also be given in regard to milling machine, or lathe, or planer work, and the subject could even be carried so far as to cover the cost of equipping a plant for turning out certain classes of machinery; or of making jigs and fixtures for a certain piece; or of equipping a tool room for a manufacturing plant of a certain size and kind. These suggestions, we think, will be sufficient, and we trust that some of our readers will find it convenient to contribute notes along the lines indicated.

* * *

One would infer from a recent item in the daily press, that the Association of Licensed Automobile Manufacturers, who control the famous Seldon patent, had scored an important point through an injunction in the case of one Moore, a man who recently came to this country, and attempted to operate an imported gasoline car. But it is not so. The Seldon patent is supposed to be a basic patent upon the combination of a gasoline engine, a vehicle and clutch connecting the engine with the driving axle of the vehicle. This patent is the tie that binds together the Association of Licensed Automobile Manufacturers and this organization is attempting to prevent any but licensed cars being either manufactured or used. The *Horseless Age* explains that the injunction against Moore has no particular bearing upon the main point at issue. When the validity of a patent is once sustained, the owners of the patent can have injunctions issued against all infringers, but no court ruling has yet been rendered with respect to the validity of the Seldon patent. The injunction against Moore was not issued for infringing the patent, but because he failed to put in a defense and so lost the case by default. Litigation is now in progress between the Ford Motor Company and the Association of Licensed Automobile Manufacturers, and this will probably be the first decision with respect to the validity of the patent.

* * *

WHY THE TURBINE HAS SUCCEEDED.

One of our contemporaries has been explaining why the steam turbine has met with phenomenal success, and has risen above the horizon of the steam-power field with startling rapidity. It is pointed out, that while we have heard about the turbine for only a few years, inventors have really been at work upon it for many years; that as the steam engine has now reached its highest state of development, it is in order for something else to come to the front; that as the steam turbine has proven to be efficient, simple and durable, it must, as a matter of course, displace the reciprocating engine for many purposes; and so on, outlining from beginning to end the history and advantages of this prime mover.

It is safe to say that the turbine could not have automatically displaced the steam engine to the extent that it has. Such displacement is due to the fact that there were hard pushers behind, granting, of course, that the turbine has merit.

A few years ago the two large electrical companies of America found it desirable to manufacture their own prime movers, as well as generators, for the large power plants they were so frequently called upon to equip. The indications were that power would thereafter be concentrated more and more in large central stations. Big power units require big firms to build them, and above all, to market them, and the question was whether these two big concerns should build steam engines or steam turbines. One of them did, in fact, start to build large vertical engines; but the turbine had such possibilities that both eventually decided in its favor, and their immense resources were directed toward perfecting the steam turbine. They have succeeded in bringing the turbine to a high state of efficiency in a remarkably short space of time; and what is more to the point, in scooping the orders for large generating units. It is not to be supposed for an instant that the turbine could have reached its present status had it not been backed by the resources of large and wealthy companies, having extensive business connections. The development of the Parsons turbine in England extended over many years, previous to its introduction in this country, and if the Curtis turbine, for example, had been taken up in a small way, as was the Parsons turbine at first, it would also have required many years to have given it its present standing in competition with the products of the leading engine builders. An analysis of the situation on the continent will show that practically the same thing is transpiring. It is the large firms, or combinations of such firms, that are succeeding with the turbine. The small firm must work more slowly and carefully, but we believe that many of the "little fellows" will eventually figure in the turbine industry, and be successful competitors.

* * *

There is a movement under foot to establish a school to train textile salesmen, following the plan of the Lowell Textile School, where students learn to design textile fabrics and to carry through the processes of manufacture from the spinning room to the inspection bench. It is contended that those who sell textile products ought to know something about their manufacture, as well as to be instructed in the devious ways of the wily salesman. Those who have occasion to visit the stores in our various cities where machinery is sold may well wish that something of the kind might be done for the innocent salesman who attempts to explain the intricacies, or in many cases, even the simplicities, of the modern machine tool. Complex or simple, however, the salesman is sure to become tangled up and to flounder hopelessly when he gets beyond the "superior workmanship" or "highest quality" stage of the discussion and tries to enter the field of mechanics.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Although the steam turbine of the Parson type is an exceedingly simple machine in the matter of operation, there is one feature of the construction which is not so simple, and that is the setting of the multiplicity of blades. This work not only requires care and skill, but it is an enormous task on the larger sizes. For example the rotor of one of the turbines of the steamer *Victorian* contains 750,000 blades according to a statement in the September issue of *Marine Engineering*. This vessel, by the way, is the first turbine steamer built for Trans-Atlantic service. It will ply between Liverpool and Montreal. It is 540 feet long, 60 feet broad and 42½ feet deep, having a capacity of 10,630 tons and accommodations for 1,500 passengers.

A recent consular report says that about twelve hundred flint-lock muskets are turned out weekly in Birmingham, England, and that a large number of this antiquated firearm is also made at Leeds, Belgium. It appears that these guns are sent to Central and East Africa for use by the natives, to whom the possession of modern rifles is denied by law; but this market is not the only one enjoyed by the manufacturers, it being quite the fad for American travelers to buy such weapons under the impression that they are getting something quite antique. It is said that the demand for old weapons is so great during the American tourists' season that the genuine article would go but a short way to supply it.

A correspondent of *Engineering* (London) says that in designing some tables for a slide rule, he tried to devise a simple formula for obtaining the sine of an angle when no printed tables were at hand and worked out the following formula which gives a very close approximation below 80 degrees:

$$\text{Radius} = 1000.$$

$$\frac{\theta}{10} = a.$$

Then $$\sin\theta = 174a - (a^3 \times 0.81).$$

Examples.

Angles, deg.	Sine by Tables.	Sine by Formula.	Error.	Error.
5	87.1	86.8	0.3	1 in 286
20	342.0	341.5	0.5	1 in 684
40	642.8	644.2	1.4	1 in 460
60	866.0	869.1	3.1	1 in 280
80	984.8	977.3	7.5	1 in 131

Beyond 80 degrees the error increases rapidly. For all practical purposes, the coefficient 0.81 may be taken as 0.8.

The superheated steam problem has been so intensified by the advent of the steam turbine that some definite data on the subject may be expected before long. The reports from one class of users, whose power plants carry a steady load, are most favorable; they are having no trouble to speak of and are satisfied with the results. There is another class, however, whose remarks on superheat are wholly unfit for publication. They have been trying to use high superheat with power units carrying loads subject to sudden and heavy fluctuations. The result of these is an occasional excessive rise in temperature, which causes all sorts of trouble in the piping and valves. It has even caused havoc in steam turbines, if numerous current reports have any substantial basis of truth. This is not at all surprising, for the clearances of turbines are very small, and the rapid and high rise in the temperature of superheated steam when a heavy load is largely thrown off with suddenness might reasonably be expected to cause overheating of the rotors and guides, with attendant binding. It is understood that the regulation of superheating is now receiving the attention of a number of specialists.—*Engineering Record.*

Assuming that coal would be used in the plant with a value of 12,000 B. T. U. per pound, and that the efficiency of the boiler be 60 per cent., each pound of coal will transmit to the boiler 7,200 B. T. U. Since each pound of water takes up 30 B. T. U. on its passage through the heating boiler, 1 pound of coal will heat 240 pounds or 28.8 gallons of water. This is equivalent to supplying under extreme conditions of heat loss, 28.8 square feet of radiation. In condensing, low-pressure steam gives up approximately its latent heat, or about 966 B. T. U. per pound, and since each boiler horse-power is equivalent to 34.5 pounds of water evaporated at atmospheric pressure, we have 1 boiler horse-power equal to 33,327 B. T. U. Now since each pound of coal transfers to the water 7,200 B. T. U., 1 boiler horse-power would require 33,327 ÷ 7,200 = 4.63 pounds of coal. One pound of coal we found to supply 28.3 square feet of radiation, consequently 1 boiler horse-power would, from the above figures, supply 4.63 × 28.8 = 133.24 square feet of radiation. Boilers are usually estimated for service per each 100 H. P., consequently a 100-H. P. boiler would supply 13,324 square feet of water-heating surface.—*Domestic Engineering.*

That the cast-iron car-wheel can be made stronger and more durable by making it more elastic is an idea advocated by the *Railway Master Mechanic*. It holds that the popular form of the double plate wheel must be abandoned, for that type is most rigid of all and contains metal where it is least needed. By reducing the rigidity of that portion between the rim and the hub the wheel will be more flexible, both laterally and vertically, thus making it better able to withstand shocks. With the more flexible construction the flange, which is now the weakest part, will in effect be strengthened, as the shock will not be localized on the root of the flange, but will be transferred more largely to the body of the wheel. The flange is the only part of the modern car-wheel that has not been enlarged, simply because it cannot be thickened on account of the limits imposed by frogs and crossings; but the need of a thicker flange, it is believed, will disappear with the advent of the wheel that has better material and with the material so placed as to combine strength with minimum rigidity. A number of 700-pound wheels which closely conform to the ideas expressed above are now running under 100,000-pound cars successfully. The wheels are made of charcoal iron and this seems to be the metal that will necessarily be used in improving the cast-iron wheel.

One of the papers presented before the National Electric Light Association at the June convention held in Denver and Colorado Springs, Colo., consisted of kinks and wrinkles contributed by stationary engineers in various parts of the country. One of these wrinkles, contributed by Mr. G. H. Cushman, San Antonio, Texas, recommends the use of chain drive to replace the time-honored governor belt as follows:

"Since it is the duty of a governor on an engine to adjust the supply of steam admitted to the cylinder to suit the load, the medium of transmission of power to drive the governor must act as quickly as possible. It is the duty of the fly-wheel to take care of the variations of the load instantaneously, while governor adjusts same by controlling the steam—taking a comparatively longer period of time to do so. We also know that under best conditions possible there is belt slippage and furthermore that a belt may break without giving any warning. To overcome these deficiences we have replaced the governor belt on three engines by a silent chain-drive, and we are well pleased with the change. To do this a special sprocket wheel had to be made to fit over the engine shaft; a sprocket was also made to replace the governor pulley. The silent chain-drive has four advantages over the belt, in that it cannot slip, it does not stretch, oil does not ruin it, and it is stronger."

In a recent issue of the *Patternmaker*, Mr. Joseph L. Gobeille, of the Gobeille Pattern Co., Cleveland, Ohio, tells how he estimates the weight of ornamental light castings from the patterns. The plan will be recognized as a very old idea, originating, we are told, with that ancient worthy Archimedes, but its application to wooden patterns has the savor of novelty:

"In estimating the weight of a cook stove from the wood

patterns, the ordinary practice is to weigh the patterns, allowing a pound of iron for each ounce indicated, and then adding thereto ten per cent. This method is fairly accurate with patterns made entirely of wood; but take an oven door after it is ornamented and there are other materials to account for, such as composition, varnish, and very often lead if the ornamentation be heavy and bold. Estimating weight by this formula on such a pattern is like looking at the sun to tell the time of day. You will make a close guess, perhaps, but it will be only a guess. To get accurately at the solution of such problems, I made a tank 24 × 36 inches and 12 inches deep, and for 3 inches of the top I graduated a scale into 1-64ths inches. This tank was leveled up and filled with water to the lower lines of the scale. The pattern, well-varnished, was plunged into the tank for a moment, the displacement noted, then taken out and wiped off. If the reading of the scale showed a rise of 1/8 inch, then I knew that the casting, under ordinary circumstances, would weigh thirty-one pounds when set up in the finished stove. The constancy and accuracy of this method are marvelous and have been a source of wonder to many foundrymen to whom I showed my simple expedient for the first time."

POWER SAVING IN MACHINE SHOPS.

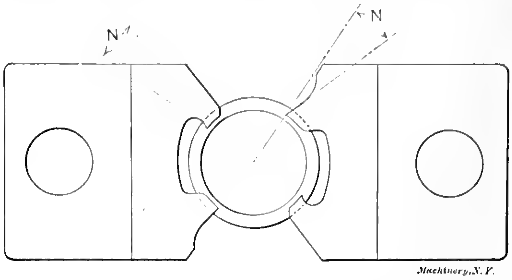
Electricity, August 23, 1905.

Machine shops in the United States are predisposed to improvements. They are the most progressive of all our institutions. They are places where a man's time is valuable enough to call for as much care in its utilization as circumstances will permit. Every hour of time saved by the intelligent manner in which work is done not only means profit to the shop but it means as well a reputation for dispatch. For this reason the machine shop has become the scene of the use of automatic appliances. It has become a true engineering center in which is focused the inventiveness, skill and labor of the best class of our constructors. And in addition, it has led to the investigation of certain important problems in shop economy which relate to the cost of turning out work, and in some respects, to the time as well. The features of this kind, to which attention is directed, are those of shaft and belt friction, and the cost of this manner of transmitting and distributing power, in comparison with the more up-to-date method of using individual motors for each machine. Tests of the efficiency in the first case gave rise to an interesting series of results, among the most important of which was a surprisingly high figure for the wasted power. This, as may be imagined, was only due to the friction developed by the stiff belts and countershafts employed in these shops, and it is not difficult to trace this waste again to the thickening of oil in the bearings and the change in the flexibility of the belting. In a shop using 1,000 H. P., the countershafting consumes nearly 400 H. P. From a dollar and cents standpoint, estimating the cost of a horse power at $50 a year, the extent of this loss can be measured up in the annual waste of $20,000. An installation of motors would naturally represent a greater expenditure in the first place, but the efficiency would readily average over 80 per cent net and perhaps 90. From this standpoint, a saving of over $10,000 appears. A saving of this kind certainly warrants an investment of at least five times as much, or $50,000, in electrical transmission machinery. Machine shop saving in this respect, in large shops at least, means a profit in the operating expense. Modern machine shop practice is a scientific as well as a financial and mechanical proposition.

SHAPE OF DIES FOR THREADING STEEL PIPE.

Railroad Gazette, July 21, 1905.

Since the introduction of modern weldable Bessemer steel for pipe considerable trouble has been experienced in cutting satisfactory threads on it. The National Tube Company, Pittsburg, Pa., investigated the matter with a view of finding the cause of the above trouble. After much experimenting the die department of the company found that the trouble was largely due to insufficient rake and clearance being given to the threading of dies. Without the proper rake and clearance the thread is ragged and torn and the tool wears quickly. There are also other points peculiar to the construction of threading dies which have to do with the results obtained, but all things being considered it was found that the angle of rake (*N* in the sketch) is the point which has most to do with efficiency, and is also the feature which is generally overlooked in the tools commonly supplied to the trade. A properly designed die is particularly necessary for threading soft steel pipe, but at the same time a correctly shaped die will work to better advantage on iron pipe than one improperly made, as truer threads and consequently tighter joints will be the result as



well as lower cost of threading and less damage to the pipe and dies. A die, to work properly and to give a clean, true thread, must have the proper amount of rake, as shown in the illustration; the chasers must be rigidly held and controlled close to the work with a due regard to chip room, and sufficient lubricating oil must also be employed. The following angles between a line through the center of the pipe and the cutting face of the chaser at the point of contact with the pipe are submitted by Frank N. Speller, metallurgical engineer of the National Tube Company, as giving the best results in practice:

Size.	Angle N.	Size.	Angle N.
1-inch........	26 degrees.	6-inch........	22 degrees.
2-inch........	25 "	8-inch........	20 "
3-inch........	25 "	10-inch........	20 "
4-inch........	23 "	12-inch........	18 "

TIDAL POWER.

Practical Engineer, August 11, 1905.

The idea of tidal motors has long been an attractive one, and as an idea there is much to be said for it. There is no perpetual motion madness nor any fundamental or mechanical unsoundness in a proposal to utilize for power purposes the rise and fall of water brought about by tidal influences. Any engineer could undertake to get work done by the tide. But he could also do the work very much cheaper, and with greater convenience to all concerned, in other ways. An engineer has been defined as a man who can do for one dollar that which any fool could do for two. And such a definition has obviously its limitations, but it will serve to remind us that in tidal power schemes, as in most other things, we have to consider not merely the cost of carrying them into effect, but such cost as compared with the cost of attaining the same result another way.

Of the many proposals put forth in connection with the harnessing of the tide for industrial purposes, the simplest and probably the oldest comprises the employment of a pontoon or large float, which is raised by an incoming and falls with an outgoing tide. Various mechanical contrivances, some of considerable ingenuity, have been devised for the conversion of the slow reciprocating movement of the float into a rotary motion in one direction of a shaft, from which the power is taken by any suitable transmitting gear. From a mechanical point of view many of such arrangements leave little if anything to be desired. Their non-success arises from the fact that for obtaining an appreciable amount of power a float of very great size is required. As an example, let it be assumed that the float be placed at a position where there is a mean difference of as much as 36 feet between high and low water. Taking it as six hours between high and low water, the float will descend through a distance of 36 feet, which represents an average of 6 feet an hour or one-tenth of a foot per minute. If, therefore, we require to obtain only 10 H. P. throughout that period, it will be seen that the float

must have a weight of no less than 33,000 × 10 ÷ 1-10 = 3,300,-000 = nearly 1,500 tons.

The foregoing very simple figures will give some idea as to the size of pontoons required for the supply of the power necessary for, say, a small electric-lighting station. As we write there occurs to us the remark made on such a proposal by a well-known engineer, to the effect that according to his calculations a pontoon as big as a house would only give one cat power.

The practical uselessness of the float or pontoon for tidal motor service has led, no doubt, to the suggestion of impounding reservoirs, and the employment therewith of water wheels or turbines. Many forms of such an arrangement have been set out on paper, and some of them look quite attractive and of considerable promise. But here again the difficulty of size is met with. Very large reservoirs and the employment of much plant will yield but a small quantity of power. There are, we believe, some instances in this country where, on a small scale, something of this kind has been accomplished with advantage, but in general it does not appear that there are many places where the utilization of tidal waters would be worth attempting. The thing can be done, but not with profit.

CASTING BRASS OR BRONZE ON IRON.

Practical Engineer, August 11, 1905.

For some purposes it is desirable to cast brass or bronze on to iron, and in such cases there is usually trouble, as the alloy comes more or less spongy. Nevertheless, such work can be done, and done well if the thickness of the alloy is sufficient, and if the following hints are followed satisfactory results will be obtained after a few trials. Say that we take

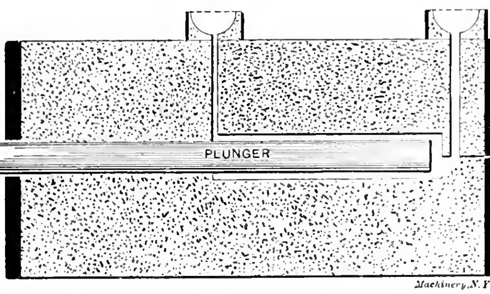


Fig. 1. Casting the First Layer.

a pump plunger as an example, and often it would pay to have a wrought-iron or steel center, with a bronze working part of from ¼ inch to ½ inch in thickness. This would, of course, be cast, and after boring be forced on the steel or iron, but this means a lot of work and waste, which would be avoided if the bronze was directly cast on. To do the casting on to the center, the iron or steel should first be tinned,

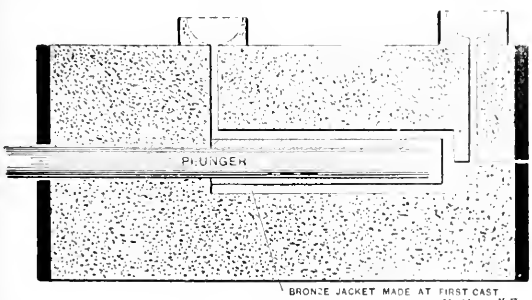


Fig. 2. Casting the Second Layer.

if facilities are at hand, but if this is not a conveniently performed operation it may be neglected, simply making the iron or steel quite clean and bright.

When all is ready, a mold should be made to give half the thickness of bronze in the center, and to a rather greater length than the finished covering is to be, the center being then put in as a core, and fluid metal poured to fill the mould, as shown in Fig. 1, care being taken that both heads are full. There will be some spluttering if the core is untinned, but by pouring at the end this will not cause much trouble, although a few splashes may fly about. A long box will have to be used, and in many cases one end of both drag and cope will have to be cut away to permit the steel or iron plunger to pass through; with short ones, however, this will not be necessary.

When practically cold, the work should be taken from the mold, the runner and riser cut off close, and the bronze thoroughly cleaned from sand and brushed up bright, having it ready for placing in the second mold.

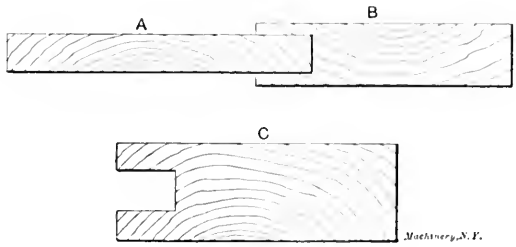


Fig. 3. Pattern with Interchangeable Bodes.

The second mold will be prepared in the same way as the first one, but, in addition to an allowance for shrinkage, an allowance for turning must be made, and when the plunger is in position a section of the mold would appear as in Fig. 2. In this case the metal will be run through the mold, a little overflowing from the riser into a pool on top of the box, as this removes any dirt that may have risen to the top of the mold, and also insures the soundness of the bronze cast on. When cold the bronze is turned down in the ordinary way, and should be solid. The porousness of the first metal cast on the iron or steel affords a good keying for the second lot cast, while the contraction of the metal in cooling holds it immovably on to the iron or steel. Either brass, bronze, or phosphor bronze can be cast on in the way described, provided it is run in a fluid state, and well skimmed before pouring. Preferentially, the pouring should be done with a good head of metal, and the entrance to the mold should be in the drag, as shown in the illustrations.

The patterns for a plunger should be in three pieces, as shown in Fig. 3, and may be well made in pine. *A* is the "print" for the plunger, and is turned up exactly to size; *B* is the pattern for the first cast, and *C* that for the second cast, the part *A* being made to slip firmly into either *B* or *C*, as occasion requires. Other patterns will be made on the same principle for double casting, and will, of course, vary with the articles to be treated.

PREPARING DEAD SURFACES ON BRASS.

Brass World.

The dead dip is the one which is used to impart a satiny or crystalline finish to the surfaces of ornamental brass articles. The bright dip gives the smooth, shining, and perfectly even surface, but the dead dip produces a surface which is most beautiful. When properly done there is just enough life to it to give a pleasing appearance, but yet not sufficient to give false light reflections like a highly-polished surface. It is by far the most pleasing of any dip finishes, and can be used as a base for many secondary finishes. Sulphate of zinc in a finely-divided form is necessary for the dead surface, and is the essential difference between it and the bright dip. The most modern method of making up the dead dip is to produce the sulphate of zinc directly in the solution and in the precipitated form.

Take 1 gallon of yellow aqua-fortis (38 deg.) and place in a stone crock which is surrounded with cold water. The cold water is to keep the heat, which is formed by the reaction, from evaporating the acid. Now add metallic zinc in small pieces at a time until the acid will dissolve no more. The zinc may be in any convenient form: sheet clippings, lumps,

granulated, or any other shape which is such that it may be added little by little. If all is added at once, the action is so violent that it will boil over. When the acid will dissolve no more zinc, it will be found that some of the acid has evaporated by the heat, and it will be necessary to add enough fresh acid to make up the original gallon. When this is done add 1 gallon of strong oil of vitriol. The mixture should be stirred with a wooden paddle while the oil of vitriol is being added.

As the sulphuric acid is being added it will be noticed that the solution begins to grow milky, and finally the whole has the consistency of thick cream. This is caused by the sulphuric acid (oil of vitriol) precipitating the sulphate of zinc. Thus the very finely-divided precipitate of sulphate of zinc is formed. If one desires to use known quantities of acid and zinc, the following amounts may be taken:

Oil of vitriol	1 gallon
Aqua-fortis (38 deg.)	1 gallon
Metallic zinc	6 ounces

In dissolving the zinc in the aqua-fortis it is necessary to be sure that none remains undissolved in the bottom, as this would spoil the results.

The dead or matt dip is used hot, and therefore, is kept in a stone crock surrounded with hot water. To use it, the articles to be matted are polished and cleaned in the usual manner, and the dip thoroughly stirred with a wooden paddle so as to bring up the sulphate of zinc which has settled to the bottom. Now dip the work in the solution and allow it to remain until the requisite matt is obtained. This is a point which can be learned only by experience. When the brass article is first introduced, there is a rapid action on the surface, but in a few seconds this slows down so that there is scarcely any. Now remove the article, and rinse and immediately dip into the usual bright dip. This is necessary for the reason that the dead dip produces a dark coating upon the surface, which, were it left on, would not show the real effect or the color of the metal. The bright dip, however, removes this, and exposes the true dead surface.

The usual rule for making up the dead dip is to use equal parts of oil of vitriol and aqua-fortis, but these may be altered to suit the case. More oil of vitriol gives a finer matt, while a larger quantity of aqua-fortis will give a coarser matt. When the dip becomes old it is unnecessary to add more zinc, as it never requires it, on account of a little going into the solution each time anything is dipped. After a while, however, the solution becomes loaded with copper salts, and should then be thrown away.

A new dip does not work well, and will not give good results when used at once. It is usual to allow it to remain over night, when it will be found to be in a better working condition in the morning. A new dip will frequently refuse to work, and the addition of a little water will often start it. The water must be used sparingly, however, and only when necessary. Water, as a usual thing, spoils a dead dip, and must be avoided. After a little while it may be necessary to add a little more aqua-fortis, and this may be introduced as desired. Much care is needed in working the dead dip, and it is something that requires constant watching and experience if uniform results are to be obtained. The chief difficulty in working the dead dip is to have to match a given article which is brought in to the dipper. No difficulty is found in producing the dead dip, if the solution is made up properly, but to have to match what is on a sample that has been submitted is one that tests the skill of a dipper more than anything else. The only way that it can be done is to "cut and try" and add aqua-fortis or oil of vitriol as the case requires. The dead or matt dip can be obtained only upon brass or German silver. In other words, only on alloys which contain zinc. The best results are obtained upon yellow brass high in zinc.

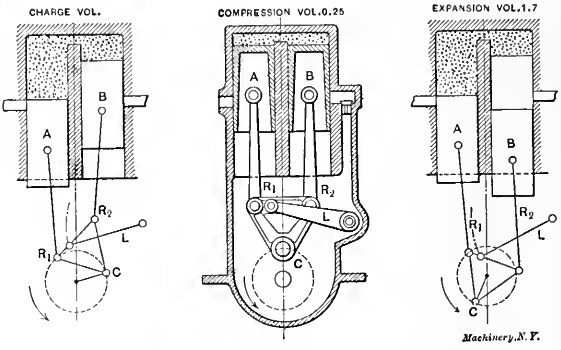
THE LISTER TWO-CYCLE ENGINE.

The Engineer, September 15, 1905.

Two parallel cylinders, A and B, are provided, the latter being the inlet cylinder and the former the exhaust, a compression chamber, which is common to both, being arranged between the two cylinders. Each cylinder has its piston connected to a triangular frame C by rods denoted R_1, R_2. One angle is coupled to the crank pin and the movement of the frame is controlled by the radius rod L, which is pivoted to the casing of the engine.

As indicated in the diagrams, the charge is expanded to 1.7 its initial volume before exhaust takes place, and the combined effective power strokes of the two pistons are said to be approximately equal to 1.8 the crank stroke, the compression portion of the return stroke being equal to 1.2 the crank stroke. The designer, Mr. Lister, of Keighley, Eng., holds that an engine of this type can be constructed with a small unit of weight per horse power and a high efficiency, at the same time occupying but small space.

When the crank is rotating in the direction of the arrow, as noted in the middle view, commencing with the position at the completion of the compression stroke, the pressure which is generated acts simultaneously on both pistons as the



ignition takes place. Piston A follows piston B in its travel, and the latter has approached the end of its out stroke when piston A reaches the exhaust port. The expansion figure shows the volume at this point, the exhaust then taking place and the pressure immediately drops to that of the atmosphere. An inlet port provided with a back pressure valve connected by a passage to the enclosed crank chambers, then having been uncovered by piston B, allows a volume of air under pressure to pass into the cylinder B as a scavenging charge sweeping out the waste gases from the explosion preceding, and thoroughly cleaning the compression space and cylinder of those burnt gases.

Again, in advance of piston A, piston B commences its up stroke, and forces out a further volume of contents from the cylinder A, and approaches the end of its stroke at the time when the piston A is closing the exhaust port. The volume before compression is then as shown in the charge diagram at the left. A charge of oil or other liquid fuel is pumped into cylinder B shortly before the closing of the exhaust port, in such a way as to mix intimately with the air in the cylinder, forming an explosive mixture which is ignited after being compressed.

This cycle is repeated at each revolution, so that this engine, in common with all two-cycle engines, has an operating impulse at every revolution of the single crank shaft, thus differing from the engines of the four-cycle or Otto principle, which have an impulse every two revolutions.

Mr. Lister claims that the volume of cylinder contents at the point of exhaust is from 50 to 70 per cent greater than the initial volume of the charge before the commencement of compression, resulting in a noiseless exhaust, better combustion, and increased efficiency. He holds that with the free exhaust port the loss from back pressure is avoided, and with this design of engine there is a positive scavenging action without any loss of incoming explosive charge. Another feature of utility claimed for this engine is the rapid expansion with consequent reduction in the cylinder wall losses. There is also a definite full charge of explosion mixture at all speeds and under all conditions of temperature. The short connecting rods have a greatly reduced angle of pressure which does not exceed 5 degrees at any point of the working stroke. This is of great importance as the lubrication is excellent and the cylinder and piston wear are equally distributed.

MACHINE FOR ROUNDING AUTOMOBILE TRANSMISSION GEAR TEETH.

The *Revue De Mecanique* of Paris, publishes a description of a machine for rounding the ends of the teeth of the gears used in the sliding gear transmission system for automobiles, which ought to be of interest to American manufacturers. In Fig. 2, *L* is the head carrying the work arbor on which may be seen mounted the work. This arbor is revolved continuously by gear *D*, through change gears, and a nest of gears in box *E*. The cutter is mounted in the end of the

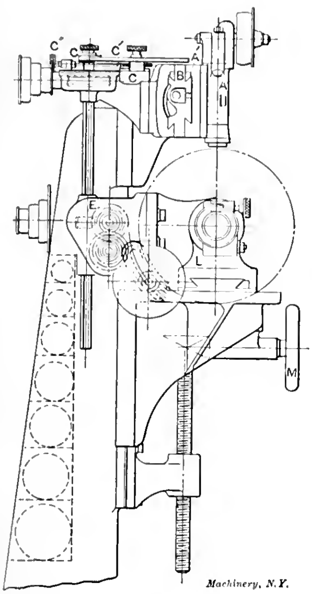


Fig. 1.

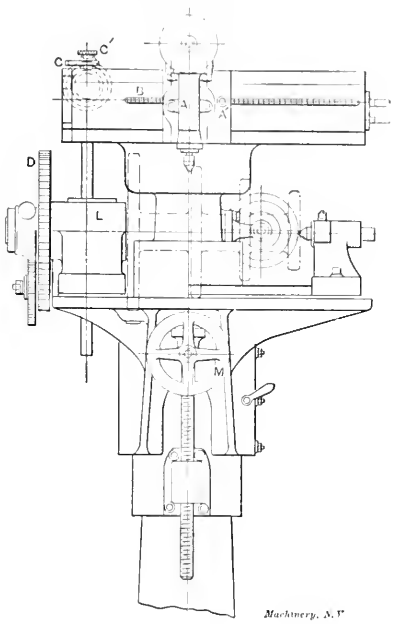


Fig. 2.

spindle in head *A*, which has a slight swiveling adjustment. It is driven through bevel gears by the pulley seen at the top of the head. This head *A* is fixed to the slide *A'*, which may be clamped at any point on the crossrail *B*; the slide is given a reciprocating motion by means of lever *C''* seen in Fig. 3 and cam *C*. Cam *C* is driven through a worm and worm wheel by the cone pulley plainly shown in the top view. The shaft on which this cam is mounted extends down through to the change gear box which governs the movement of the dividing wheel *D*.

In the operation of the machine, with the spindle *A* revolving continuously, and the work being rotated through the change gears at the proper rate, the cam will move the cutter in and out of the spaces between the teeth, as they present themselves with such a movement that the cutter will give the desired profile to the corner of the tooth. The cone of gears in gear case *E* may be given such ratios that they will correspond to the ratios of the transmission gears whose teeth are being rounded. In this case, in changing from one gear to another in the series, the push pin of the nest of gears will simply be pushed in or out to correspond with the gear being cut. The lever *C''* may be located on either side of the cam *C* so that both sides of the gear may be operated on without its being necessary to reverse the work in the machine. A spring is concealed in the crossrail *B* which opposes the movement given it by the cam; the pressure imposed by this spring may also be reversed by turning the shaft which projects at the end of the crossrail. In working on gears of varying diameters the work-table is elevated or depressed by hand wheel *M*. For varying the outline of the round which is given to the corner of the gear tooth, the pivot of lever *C''* is moved in or out by the knurled head screw *c''*. It is unnecessary therefore to change the cam except where a radically different shaped tooth corner is required, such as a bevelled corner, for instance.

This machine is built by M. Marcel Lejeune, 93 Rue d' Angolême, Paris, France.

OIL FURNACES.*

When the larger part of our output was the result of hand labor, the heating of the material was a simple question, the quality of heat being the only consideration necessary, as any of the coal or coke fires could easily supply sufficient working material, but at present a very large percentage of our work is machine blacksmithing and it is absolutely necessary to supply the various machines with raw material, properly heated, and in large enough quantities to work them to their full capacities. These machines cost the railroad a large amount of money and if not turning out finished material in quantities approximating their capacities, are expensive investments.

In looking for a method of increasing heating facilities for machine work, petroleum, so bountifully supplied by nature, was naturally a great attraction. Crude petroleum or fuel oil, which is commonly used, has a very high heating efficiency containing from 20,000 to 22,000 heat units per pound as compared with from 12,000 to 14,000 per pound of coal.

It is capable of practically perfect combustion, leaving no ash, and when properly handled producing no smoke. The quality of the heat is as satisfactory as coal or coke, if generated in the proper manner.

The mere act of burning oil is a simple one, but the burning of oil and producing a proper flame is a very particular process. Atomizing the oil with air or steam under pressure through variously constructed burners and burning the resulting mixture by depending upon the heat of the furnace to keep up the combustion, is a method commonly followed. This process necessitates forcing unconsumed oil, no matter how thoroughly atomized, into the furnace. Combustion does not begin until this part of the operation has been performed, and the atomized oil has been spread over the heating area and surfaces of the furnace. More or less of it, before burning, comes in contact with the material being heated, where it carbonizes, causing imperfect combustion, and a cooling effect upon the material, thus necessitating a longer period to properly heat the iron. Again, this high pressure or atomizer system almost invariably produces an oxidizing flame, resulting in the burning of the material; bridge walls and other arrangements, somewhat help the combustion but do not overcome the oxidizing

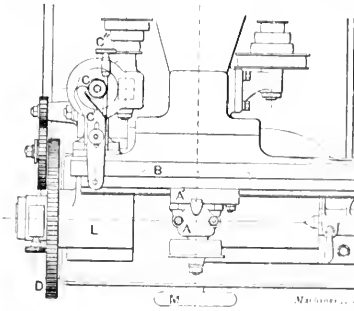


Fig. 3.

flame. Owing to our familiarity with compressed air due to its general use in our shops, few of us appreciate the high cost of producing it and its influence in increasing the cost of heating where used as an atomizing agent in oil furnaces.

These several objections to the atomizer system were appreciated back in the early 90's by a brother railroad man, and to his thorough study of the subject and his years of experimental work we are indebted for ideas which have been developed into the low pressure and economical process known by his name to-day. He eliminated the expensive

* Paper by Mr. John McNally, of Chicago and Northwestern Railroad.

compressed air and substituted the ordinary low pressure fan blast used in our open forges, on the theory that volume and not pressure was necessary for the successful burning of oil. With a low pressure of only a few ounces he fortunately could not successfully atomize, so was obliged to work on other lines, resulting in a process which first burned the oil in a small amount of air, thereby breaking it up into the hydro-carbons, then with heat of the subsequent combustion breaking these hydro-carbons down to gases, such as marsh gas, carbon monoxide, free hydrogen, etc., and finally supplying these gases with a second and larger volume of air burning them to completion. All of this being done in a small and independent combustion chamber, the hot gases only being forced into the heating area of the furnace. This process resulted in a very perfect combustion of the oil at a low cost of operation and supplied a soft, dry heat to the furnaces.

Very thorough and extensive tests made on this process by Prof. Kenosche at Iowa State College during the past winter, demonstrated a combustion practically perfect before entering the heating area of the furnace, a temperature above 3,000 degrees F. at the same point, and the important fact that practically no oxygen was unconsumed, resulting in a reducing flame which could not injure the material being heated.

Other low-pressure processes discharging a mixture of oil and air into a combustion chamber or furnace direct are an improvement on the high-pressure system, but do not as completely burn the oil, owing to the difficulty of supplying a sufficient quantity of oxygen at a single point, and the result is a damp oxidizing flame.

The process we are using at the Northwestern shops overcomes this difficulty by means of the secondary air supply. Having perfected the combustion, and thus insured a maximum amount of heat from the least bulk of oil, the furnace design and construction to save and use this heat, is equally important. The percentage of loss, due to radiation, is often high, but with proper construction of furnace can be made a small item. With perfect combustion stacks are not necessary and a great loss of heat can be prevented by not using them. Radiation which makes uncomfortable conditions for the men is another source of loss and should be overcome, and when well done will greatly increase the efficiency.

A pound of oil contains a given amount of heat, all of which is made available with perfect combustion, but a poorly designed and constructed furnace, even if it is apparently doing satisfactory work, may be losing enough of this heat to make the cost of the operation prohibitive. On the other hand comparative costs of coal and coke fuels depend upon locality; with properly constructed and operated oil furnaces the fuel bill can be much higher than coal or coke would be in the same furnace and still the cost of the work produced be materially lower. This is due to the greatly increased output, the greater intensity of heat, the elimination of tending fires, the short time required to bring an oil furnace to the desired working temperature, and the improved conditions under which the furnace men work.

1. The maintaining of an even heat of any desired temperature is assured with a properly constructed oil furnace.
2. The quality of work is of a higher grade.
3. The quantity of material turned out is greatly increased.

* * *

TWO GERMAN LATHE ATTACHMENTS.

The *Zeitschrift fur Werkzeugmaschinen und Werkzeuge*, in a recent review of various machine methods, illustrated the lathe attachments shown in the accompanying drawings, for turning concave and convex spherical surfaces. The first one, for turning a concave surface, is obviously simple, consisting, as it does, of the radius bar, *A*, of the required length, which is pivoted to holder *D*, clamped on the tailstock spindle. At *B* it is pivoted to the cross-slide, and, as the latter travels across the surface of the arc being faced, it is forced to move in an arc, the radius of which, of course, is equal to that of the radius member *A*. But the arrangement shown in Fig. 2 for producing the convex shape is not so obvious; it is an ingenious adaptation of the same principle and is one which we believe will be new to many readers. The radius member *A* is made of the same length as the radius of the desired arc and is pivoted at *I* to a slide, *K*, free to move longitudinally on the lathe bed. The other end of *A* is pivoted to a cross-slide *F*, which moves on a guide, *E*, rigidly secured to the lathe bed. The carriage cross-slide has the roller, *G*, which engages jaws in slide *F*, and hence, as it is fed across the surface of the work, the slide *F* is carried along with the carriage cross-slide. The resultant effect of the movement of *A* is to move the block *K* along the lathe bed, and this movement is transmitted to the carriage by means of the connecting bar, *L*, making the point of the tool describe an arc of which *A* is the radius.

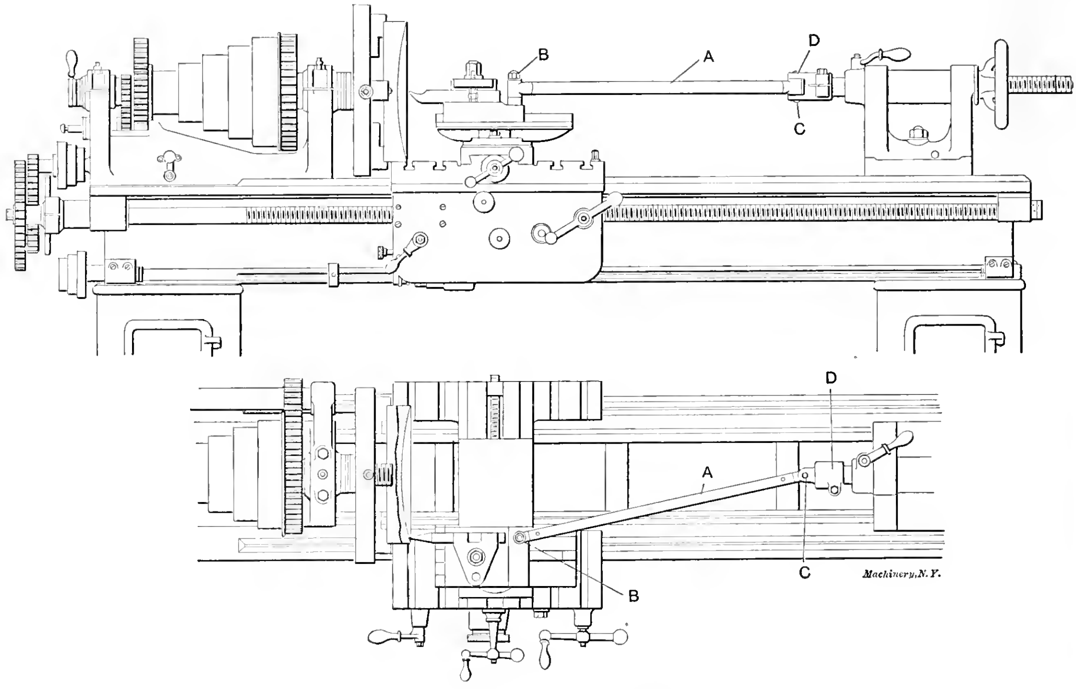
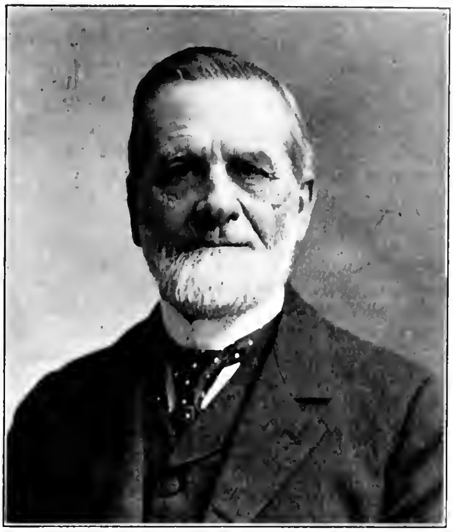


Fig. 1. Attachment for Concave Facing.

HORACE SILSBY.

The recent death of Horace C. Silsby, of Seneca Falls, N. Y., means the passing away of another man who has been intimately associated with the early industrial development of the country, and in this case with the development of one of



Horace Silsby.

the important branches of machine manufacture. Mr. Silsby was one of the pioneer builders of the steam fire engine, and probably built the first commercially successful engine manufactured in the United States. The earliest steam fire engine is believed to have been constructed in England by John Braithwaite in 1829. Captain Ericcson obtained a medal from the Mechanics' Institute of New York in 1840 for an original design of a steam fire engine which resembled, however, that produced by Braithwaite; but the first steam fire engine to be constructed in America was made by A. & B. Latta, of Cincinnati, and used by the fire department of that city in 1852, which probably had the first paid fire department. Various other builders took up the manufacture of steam fire engines after Mr. Latta, and among these was Mr. Silsby. Appleton's Dictionary of Mechanics, published in 1866, states in regard to the Cincinnati fire department, that steam fire engines had then been in use in Cincinnati for several years and according to the report of the chief engineer of the department had materially reduced the loss from fire. They had not been incorporated into the fire service of other cities, however, though they were used in isolated instances, largely as an experiment.

The father of Horace Silsby was Seth Silsby, a practical blacksmith, who is believed to have been the originator of the chopping ax with a cast-steel blade welded to an iron body. In 1833 the Silsby brothers, of which Horace was one, located at Seneca Falls for the manufacture of cast-steel axes, mill picks, etc. A shop was built for them containing four forges, where the axes were made by hand. Charcoal for welding was brought from a nearby town. The original shop is still standing at Seneca Falls, and is used for a storehouse. It was intended to use water power for grinding and finishing the axes, but the power was found insufficient, and the practice was to grind in the day time and to finish at night. As indicating the primitive commercial methods of those early days, it is interesting to note that the first house owned by Mr. Silby was paid for in axes manufactured by him and his brothers. Later his business interests shifted, and extended into mercantile lines for several years, but in 1847 Horace Silsby, with others, began the manufacture of pumps, stove plate, and regulators for stoves. This line of business increased rapidly and buildings were erected to accommodate it, as the need for them arose, until a large tract of land was covered. In 1853 Birdsell Holly, who was the inventor of an elliptical rotary pump and engine, was admitted into partnership with the firm, the name becoming Silsby, Race & Holly. Holly invented his rotary engine and pump the following year and as the attention of the public was then being attracted by the various experiments in the construction of steam fire engines that were then being carried on at Cincinnati and elsewhere, Mr. Silsby thought the Holly patent could be applied to the steam fire engine; and upon trial it proved successful. In 1856 the first Silsby steam fire engine

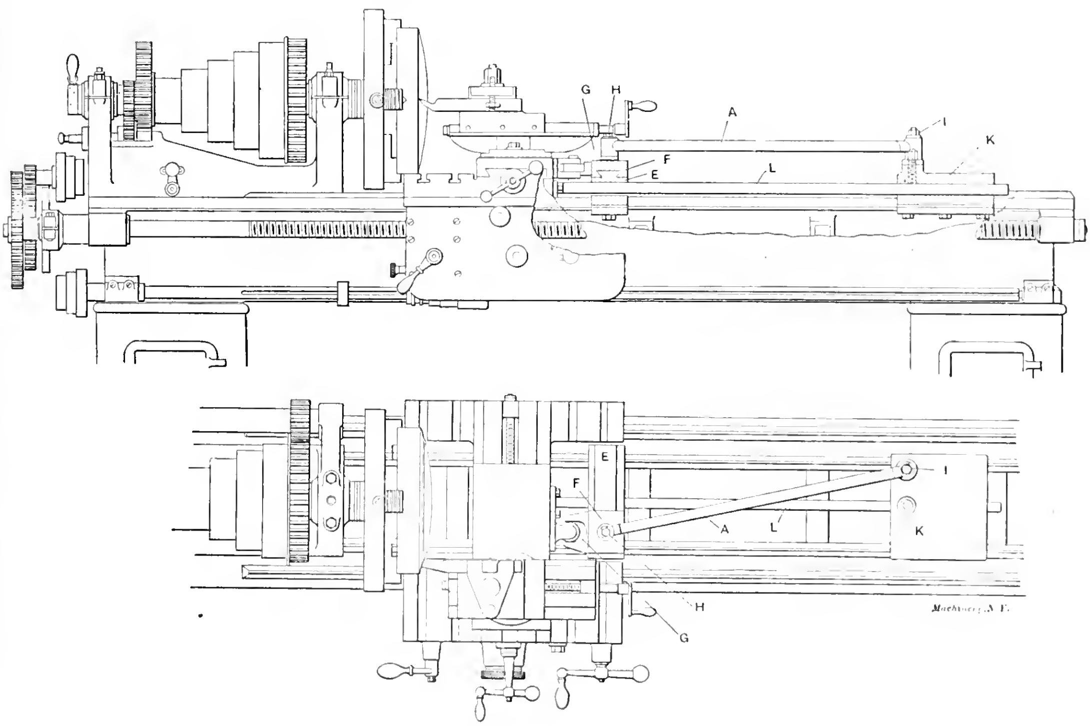


Fig. 2. Attachment for Convex Facing.

was brought out, and was exhibited at the Crystal Palace Exposition in New York; but unfortunately the operation of the machine was not satisfactory and it was taken back to Seneca Falls and consigned to the scrap heap. In 1858 the "Long John" was built, a large and tremendously heavy steamer, which overcame many of the defects of the first machine, and was so far successful that it was in commission in Chicago doing active duty for more than 14 years. The engine was so heavy that its transportation to a fire in rapid time was a matter of considerable difficulty. This machine, however, is justly characterized as a practical and a successful one and rendered more years of service with fewer alterations and repairs than any of the very early fire engines.

In 1855, or at the time the first Silsby fire engine was being constructed, Mr. Silsby bought out the interests of his partners, Mr. Race continuing the stove and regulator business, and Mr. Holly going to Lockport, N. Y., where he developed the well-known Holly water works system. He later became associated with other partners, one of whom, Mr. Mynderse, was an advocate of the piston engine, in preference to the rotary, and one of this type was built. Mr. Silsby advocated the rotary principle, however, and again became sole owner of the business, until his two sons later entered into the enterprise with him. The concern has since become the property of the American Fire Engine Co. and this company is now a part of the International Fire Engine Co., composed of practically all concerns manufacturing fire apparatus.

It is a noteworthy fact that, in spite of the hundreds of patents taken out in this country upon rotary engines, this engine and pump invented by Holly, and placed upon the market by the business enterprise of Silsby, has been the most successful of any of this type. The Silsby engines have given good satisfaction, and the service an engine and pump have to perform in fire fighting is probably better adapted to the rotary type than is almost any other duty. Such machines do not have to be extremely economical, and their work is intermittent; they receive careful attention, and the mechanism of the rotary engine is extremely simple, which is a good feature.

Mr. Silsby was nearly 90 years old at the time of his death, and in the management of the firm with which he was so long associated he always showed appreciation of the worth and genius of his employees, as evidenced by the fact that there were more old men to be found on its pay roll, who had grown gray hairs in its service, than were often to be found, even in old established shops. Mr. Silsby was regarded as the leading citizen of Seneca Falls and through his various enterprises and business connections had done much to promote the interests of his town.

* * *

DEATH OF PROF. REULEAUX.

Prof. Franz Reuleaux, of Berlin, Germany, the distinguished mechanical engineer and professor of engineering, died on August 20, at the age of 76 years. His father was the proprietor of a small machine shop, where Prof. Reuleaux's practical education began. He obtained his technical training at the Polytechnic Institute of Karlsruhe, and later studied at the universities of Berlin and Bonn. After his student days were over, he became manager of a machine shop in Cologne, and then accepted a position as instructor at the Zurich Polytechnic Institute. One of his associates at this Institute was Zeuner, who has become so widely known for his researches in thermodynamics and the mechanism of the steam engine. While at Zurich he began his work in the line of kinematics, for which he is perhaps the best known. As a result of this work he brought out his theoretical kinematics, and only a few years ago issued a second volume upon this subject, called "Applied Kinematics." In developing this subject, he succeeded in establishing relations between the different elements that enter into nearly all combinations of mechanism, so that the subject really became a science susceptible of systematic study. In 1864 he became professor at the Berlin Trade School and four years later was elected to its directorship. In 1879 he accepted an appointment at the Technical College of Berlin, where he remained over 17 years. Of his numerous literary productions, "The Constructor" is his most practical and most widely used work, this having been translated into several languages, and being extensively used in Germany, especially as a text book by students, and as a hand book by engineers.

Besides his work as a professor and investigator, Prof. Reuleaux was active in many ways as a member of different engineering societies, and as public commissioner, appointed to investigate and report upon various engineering enterprises. In 1876 he was sent by the German government to the Centennial Exposition, and in his report upon the machinery exhibition there, he emphasized the inferiority of the work of German machine shops, which he characterized as cheap and poor. This aroused a great deal of discussion, and resulted in a marked improvement in the manufacture of machines in Germany, and was probably the thing that first led Germany to take the important place she now occupies in this field. He again represented Germany at the Chicago World's Fair in 1893, but this time took occasion to compliment his countrymen upon the splendid showing they were able to make in their machine exhibition. Besides his professional duties, he accomplished much in the line of literary work, and was broadly accomplished in many ways other than the particular work to which he devoted most of his time.

* * *

OCTOBER DATA SHEET.

To judge from the great number of tables which have been sent to this office dealing with the problem of squaring mixed numbers, this question must have been occupying the minds of a great many mechanics. Of those we have on hand, the table we publish this month was selected because it contained an extended list of functions useful in many other ways besides in finding the square.

Suppose we wish to find the area of a square the length of whose side is 3 5-64 inches. According to the binomial theorem, "the sum of the squares of two numbers is equal to the square of the first, plus twice the product of the first and second, plus the square of the second." This may be expressed algebraically thus:

$$(a + b)^2 = a^2 + 2ab + b^2$$

In order then to square this quantity, 3 5-64, without reducing it to a decimal, we may add together the square of its first quantity, 3, twice the product of 3 and 5-64, and the square of 5-64. The square of 3 may be obtained mentally, likewise twice the product of the first and second terms; the square of the second term is found in the column of the data sheet headed "square." Written out, as the operation would be performed on paper, it would be expressed thus:

$$\begin{array}{rl} 3^2 & = 9. \\ 2 \times 3 \times 5/64 = 15/32 & = 0.46875 \\ 5/64^2 & = 0.006104 \\ \hline 3\ 5/64^2 & = 9.474854 \end{array}$$

It is not necessary, however, to write all this down. Taking another example, the problem is to square the quantity of 8⅛; all the calculation that needs to be done on paper is given as follows:

$$\begin{array}{r} 8^2 + ⅛^2 = 64.015626 \\ 2 \times 8 \times ⅛ = \ \ 2. \qquad \\ \hline 8⅛^2 = 66.015625 \end{array}$$

In this case the 64.015625 is readily seen to be the sum of the square of the first and second quantities, of which one is always integral and the other always fractional. Their sum may therefore be written at once as a single quantity, the square of the whole number being obtained mentally or from a table of squares, while the square of the fraction is read from the data sheet. To this is added twice the product of the first and second quantities, which amounts to 2 in this case, and may be readily calculated without using a pencil. The result which this method of squaring a mixed number gives is exactly accurate to as many places as the square has been figured to in the table of squares.

Logarithms are given for the various functions to save the usual trouble of reducing the fractions to decimals and then looking up the logarithms in the table.

BORING TOOLS.*

W. J. KAUP.

W. J. Kaup.

In a previous talk on cutting tools I confined myself entirely to one class, namely, planer and lathe tools, and the different conditions under which the best results can be obtained from them. By best results I mean the maximum amount of good work with the minimum amount of energy expended — the ideal for which every good mechanic is striving. I tried to make plain the cardinal points for securing these results, such as proper top and side rake clearance, rigid setting, tool location so that it will not spring into the work, proper relation of cutting wedge to plane of work, etc. All these combine to make the cutting edge the basis of economic production, and economic production means not only least cost in manufacture, but a saving in wear and life of the machine.

I have purposely divided the subject of cutting tools into two separate heads, as there is a recognized distinction between inside and outside turning. The rake and clearance of a tool for inside turning must be different from that used for outside turning, for two reasons: First, because of the contracted and peculiar conditions under which the boring tool works, and second, because of the spring of both tool and

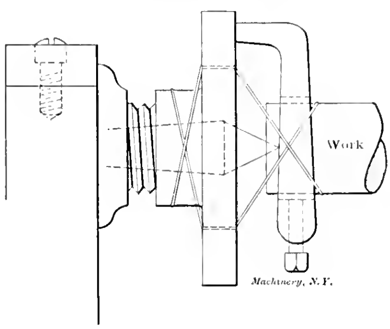


Fig. 1.

work—very serious conditions met with in boring which do not apply in outside turning. The spring of the work is overcome in many cases by using a steady rest to support one end of the work while the other end is held in the chuck, or else is clamped to the faceplate and in addition is sometimes supported by the live center itself. In the latter case it must be laced to the faceplate.

Fig. 1 may serve as a help to some who have found difficulty in keeping the work tight against the center. It shows the faceplate partly unscrewed. The lacing is made fast to a dog or carrier in that position, and the faceplate is then screwed up in place, thereby tightening the thong. Now, unless great care and skill are combined in setting the steady rest in position, the result will be failure because, in boring, the object is to get the bore concentric with the outside and it is a very easy matter to defeat this object by careless setting of the rest. A suggestion as to the way of setting may here be in order. If it is a piece that has already been turned on the outside the centers may be used to good purpose. Keep the live center in the lathe spindle, screw the chuck in position and put the work on centers, as for ordinary turning. Now bring the chuck jaws down to the work and place the rest in position at the dead center end, the work all the while being still on centers. The rest is then opened, the chuck, with the work in it, unscrewed and the center removed. This method will insure accuracy, where it can be used.

If it is a rough piece of work that is to be set, support one end by the dead center, turn a true surface for the jaws of the steady rest and place the same in position while the work is still on the center.

Fig. 2.

Fig. 2 will, I think, prove that the same laws do not hold for both inside and outside turning. The circle on the left represents a cylinder to be turned; that on the right, a hole to be bored, with the tool in position. The lines *a b* and *c d* are drawn tangent with the work at the point where the cutting edge is in contact with the work when turning and boring respectively. On the face of it, it would seem that one vertical line should answer for both conditions, but not so, for in turning we are enabled to set the cutting edge of the tool above the center of the work, hence changing the position of the lines and getting a finer cutting wedge. The angle *A* is the angle of the cutting wedge in turning, while *B* is the angle of the cutting wedge in boring. This is the best condition obtainable in boring, but it is not as good as can be desired.

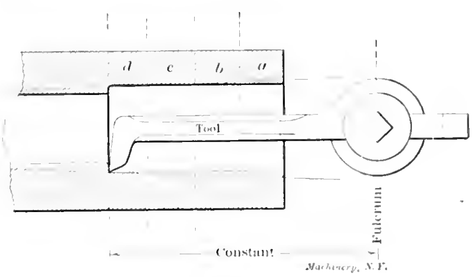


Fig. 3.

Fig. 3 shows an old-fashioned forged boring tool of the type common in every shop. These tools are forged by the tool dresser in lengths and sizes that will cover a wide range of work, so that different diameters and depths may be bored without redressing. As to results for this type of tool: When the tool starts to perform its function—takes up its cut—there is a downward spring which we call vertical deflection, due to the pressure of the chip on top of the tool. This pres-

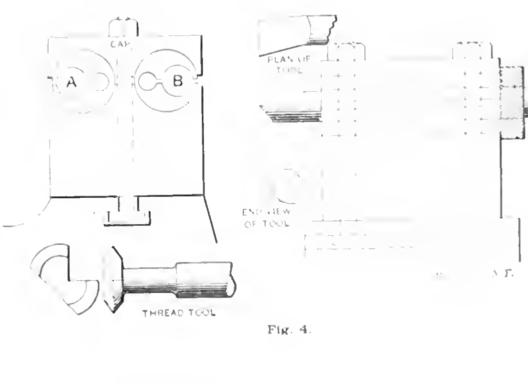


Fig. 4.

* Abstract of a lecture by W. J. Kaup, instructor in charge of the machine department, Pratt Institute, Brooklyn, N. Y. The machine shops of Pratt Institute are equipped with a great variety of modern machine tools and under Mr. Kaup's direction the course in shop practice has been developed to a high state of efficiency, and is conducted as far as possible to conform with the methods used in the best shops doing commercial work. Each year Mr. Kaup gives a series of lectures to young men, many of whom are machinists, and he has often found that instruction in some of the simpler and more elementary points connected with the subject was more urgently needed than was information upon the more complicated details. The abstract published herewith is from one of a series of lectures upon cutting tools.

sure is nearly constant throughout the entire length of the cut and does not vitally affect the accuracy of the work, particularly since there can be a slight vertical movement of the tool without appreciably changing the diameter of the surface being bored. This is not the case, however, with the lateral pressure on the boring tool, which pressure, being at right angles to the cutting edge, deflects the tool away from the work more and more as the cutting edge dulls, thereby changing the angle of motion of the tool constantly. The result is

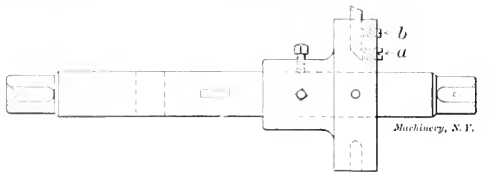


Fig. 5.

a conical hole, and much time is lost in taking repeated cuts to get the bore parallel. This type of tool, therefore, does not prove economical, although the outward or lateral pressure will vary somewhat with the shape of the tool and the way in which it is dressed.

If the front or cutting edge makes an acute angle with the work, the lateral pressure is considerable; but if the cutting edge is at right angles to the work there is less tendency to deflect the tool in a sidewise direction. In the latter case, however, as the cutting edge wears away and the tool becomes

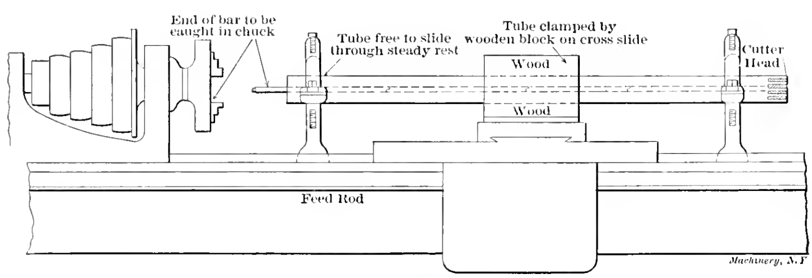


Fig. 6.

dull, there is a tendency for the corner to become worn so as to form an acute angle, and we still have some of the same trouble to contend with. Theoretically and practically, a tool ground as in Fig. 3 will give the best results, so far as cutting is concerned, but even by using the greatest care and judgment in dressing and grinding the tool, to reduce sidewise deflection, we cannot altogether remove the difficulty. This question of deflection is largely one of leverage. The amount of deflection will depend upon the length of the tool from the binding screw in the toolpost to the cutting edge.

After the tool is once made its leverage is always a constant quantity, as indicated in Fig. 3, since the tool must always be placed in approximately the same position in the toolpost. It will, therefore, deflect as much in boring a short hole as in boring a long one, assuming the cutting edge to be in the same condition in each case. The longer the tool the greater the deflection, for the tool is a cantilever the deflection of which is increased eight times when its length is doubled. From this we can readily see how important is this consideration of leverage, and how desirable it is to have the boring tool adjustable so that it need project from the point of support only so far as is necessary to bore the full depth of hole required. The mechanic should try to overcome the difficulty due to leverage by devising ways and means for making the tool adjustable. Many schemes are open to the thinking mechanic.

Fig. 4 will give an idea for a tool holder and for different tools which are inexpensive and at the same time meet the above requirement. The holder gives at all times the greatest rigidity and allows the use of the largest size of tool possible for any particular work. It also enables the operator to vary the leverage to suit each particular hole.

The holder consists of a rectangular block of cast iron in which two holes are bored, one on each side of the center, and on a plane with the lathe center, and extremely close to the edges. After this it is sawed in two through the center of the holes, the top forming the cap. The hole may be made any standard size: 1¼, 1 3-16, 1½. Into these holes are fitted sleeves or the drill rod itself, although the sleeves give wider range of size of boring tool for each holder, by having a number of sleeves with different standard size holes. The tool fits in either *A* or *B* of the sleeves. If the tool is to be used in *A*, a solid piece is inserted in *B*, so as to give a support for the cap to be clamped against. One end of the sleeve is knurled to allow for thumb and finger adjustment in raising and lowering the tool. Ordinary drill rod is used, filed down to a flat surface at the end, as shown. When heating for the tempering process, set over the filed end by a blow of a hammer for clearance. A tool nearly the size of the hole to be bored may be used. For instance, an 11-16-inch tool could easily be used to bore a ¾-inch hole. The thread tool in this type is of the greatest advantage in that the tool is always level—the requisite for a true-angle thread.

The good features of this type of tool are: first, it saves in expense in forging; second, it saves time in grinding and setting, and in boring a true hole; third, it requires less skill and judgment in getting results. As the work increases in weight and size, and it is not practicable to clamp either on faceplate or chuck, the boring bar is substituted, in which case former conditions are not encountered.

Many styles of boring bars are used, the one shown in Fig. 5 being possibly one of the simplest type. In the boring bar head you have to consider only the proper cutting edge of the tool; and attention is to be called chiefly to the method of setting out the tool for increasing the depth of cut. The tool itself has a wedge end and the set screw *a* a conical end bearing against it, thus forcing the cutter out as the screw moves in. The binding screw *b* comes in contact with a flat side filed or ground on the cutter. Heads of different sizes are made to fit the bar, to suit holes of different diameters, insuring a short tool leverage. This type of bar was used with very satisfactory results in boring fields for 5 H. P. motors. There are many improvements possible in this bar, such as feeding the tool head by means of a screw carried in the bar and receiving its rotary motion by the use of a stationary gear on the dead center spindle engaging with a gear on the end of the screw.

In many cases it is desirable to bore holes of small diameter but of great length which extend through the entire length of

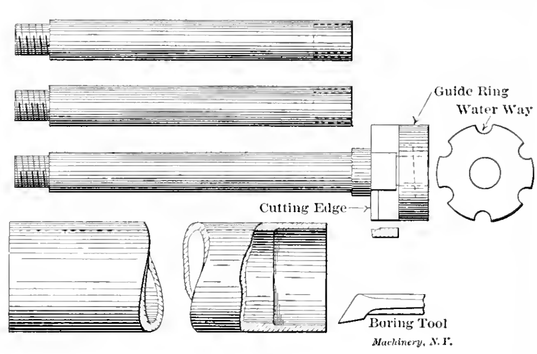


Fig. 7.

a tube, such for example, as core barrels for rock drilling, where the tube is from 10 to 14 feet long, and as small in some cases as 2 inches in diameter.

Fig. 6 will give an idea of the method by which such holes may be bored with very satisfactory results, and in Fig. 7 the boring bar is shown in detail. The bar is made up of sections, say 3 feet long, each so constructed that they can be joined together into one long bar. The work is supported in the

lathe by two steady rests and is clamped to the carriage of the lathe by means of wooden clamps, specially constructed to suit each individual case. The steady rests are only used to guide and support the tube as the carriage advances, carrying the tube with it. The end of the tube is first bored to a depth of about 2 inches with the ordinary boring tool, and made the required size. The bar is then inserted until the cutter head reaches the bored end of the tube which the guide ring on the outer end of the head should fit nicely. The tube is then clamped to the carriage, supported by the steady rests, and the

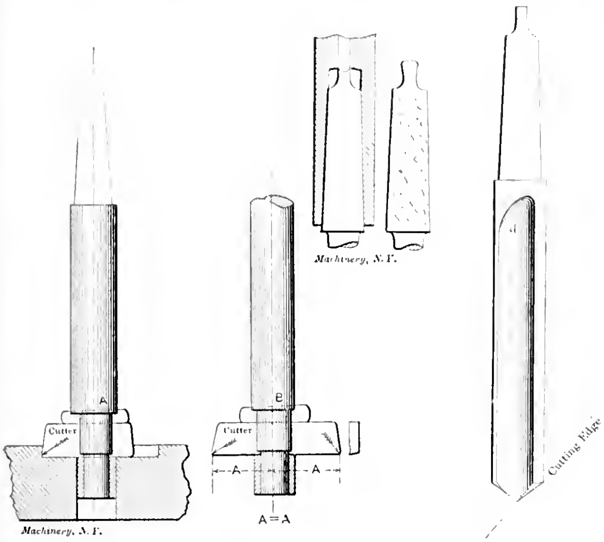


Fig. 8. Fig. 9.

other end of the bar is held by the lathe chuck. Allowance should be made for the tube to travel a distance equal to the entire length of one of the boring bar sections. When the tube is advanced this far one of the sections of the bar is unscrewed and laid aside and the chuck engages the end of the next section, and so the work proceeds until completed. It should be observed that the face only of the tool should be used as a cutting edge, while the outside acts simply as a guide.

In Fig. 8 is another common type of boring tool more generally known as a counterbore, but it is used to a great extent as a boring tool proper. It is important that there be two cutting edges, to balance or equalize the resistance and obtain round holes. Too often we find it used as a fly cutter, without the advantage of speed which is essential to the success of a fly cutter, as shown at *A*, Fig. 8. When the cutter takes up its work, the resistance due to the chip tends to push it away, and this strain is carried entirely by the bushing or guide pin of the bar, which results in the lapping out of uneven wearing in the hole. This means only one thing — the counterbored part will neither be round nor of the size intended.

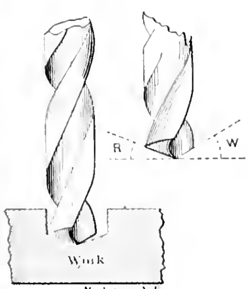


Fig. 10.

When a piece is irregular in shape, and in cases where the boring mill is not available, the drill press must be converted into a vertical mill. The work is clamped to the table of the drill press and the boring bar is carried by the drill spindle at its upper end and is guided at its lower end by a bushing in a hole at the center of the table.

By far the most important boring tool in any shop is the drill, and experience has proven that with no other type of boring tool have there been so many disappointing results as with drills. It must be patent to every mechanic that the cutting edges of the drill should have a uniform angle with the longitudinal axis of the drill and they should be properly cleared or backed off and should be of equal length. The angle for iron and steel is from 59 to 60 degrees, and for brass from 75 to 76 degrees—a greater angle in the latter case because of the tendency of the drill to hook into the softer metal, especially as the drill is about to break through the work. The angle of the point is a sure indication of the lip clearance, as illustrated at *a*, *b*, *c*, in Fig. 11. Too much clearance, as shown by *b*, will produce irregular shaped holes.

Fig. 10 indicates the results of improper grinding. One lip is much longer than the other, hence the two edges are at different cutting angles and only one lip cuts, making it impossible to drill holes anywhere near the size. Another thing that gives considerable trouble is carelessness about the point of the drill. It must be sharp or else no matter how keen the outer parts of the cutting lip may be the drill will not work without considerable pressure which in extreme cases tends to crush the drill. Another small thing but very important to observe is the starting of the drill. If it runs out of center before it begins to cut the full diameter of the hole

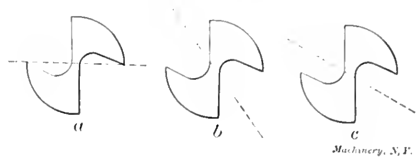


Fig. 11.

the drill should be drawn over by gouge-chiseling the countersunk portion. This is more important in holes that are to be rebored, for it is desirable that equal metal should be left on all sides for the next succeeding bar or cutter. In every instance where accurate drilling is desired it is advisable to drill a small hole first as the large drill will follow more accurately. It also relieves the point of the large drill from acting as a pivot, and a hole of more exact diameter is obtained.

Fig. 9 shows a farmer or straightening drill used successfully on cored holes. This is also available as a cannon bit for lathe work, by boring the work to a size just deep enough for the drill to enter, and by using the tailstock feed.

Another small thing that defeats good work, and the chance for promotion of many mechanics, is shown in the upper left-hand corner of the same illustration, where a little speck of dirt or a small chip came between the drill shank and the socket and made a depression in the drill shank every time the latter was driven up into the socket until the shank had a pock-marked appearance. It is just as important that the shank of the drill should fit the socket of the drill press as it is to have the center of lathes fit in their respective places.

TABLE OF FEEDS AND SPEEDS FOR DRILLS.

Size of Drill.	Rev. per Min.	Feed per Rev.	Feed Rev. per M
1/4"	380	.005	200
1/2"	180	.007	143
3/4"	110	.010	100
1	75	.014	75

The accompanying table shows the speeds at which the drills may be run. As to the feeds remember that this depends entirely on the speed at which the drill rotates, and that to get the best results with a drill the highest speed possible for each particular size of drill is essential.

* * *

The building of the great bridge over the Zambesi River at the Victoria Falls on the Cape-to-Cairo Railway has attracted much attention to these wonderful falls and to their capacity for future development. The Zambesi River is a mile wide above the falls and the cataract is 420 feet high. In short, the Victoria Falls have fully twice the volume and more than twice the height of Niagara Falls and it is estimated that the enormous power of these falls approximate 35,000,000 horse power, as against 7,500,000 horse power for Niagara. It is not improbable that this great water power will be employed for the electrification of all the immediate portions of the Cape-to-Cairo Railway, and it is not impossible, with the improvements of the electrical transmission of energy, that a generation hence may see the completion of this great railway project and its complete electrification.

SPIRAL GEAR CUTTING IN THE NATIONAL ELECTRIC COMPANY'S SHOPS.

The building of the motor-driven compressors for use with the well-known Christensen air-brake equipment for street railway cars forms a considerable part of the business of the National Electric Co., of Milwaukee, Wis., and was, in fact, the sole business of the concern in the beginning. It is, of course, very important that these air compressors, which are located beneath the floor of street cars, should run with a minimum of noise and vibration. They are electrically driven by small motors running at high speeds, hence freedom from vibration is a condition difficult to obtain with ordinary spur gears; but spiral gears seem to have solved this difficulty of construction in the Christensen compressors. These gears and pinions are made with right- and left-hand spirals, and are fastened together in pairs so as to form the balanced construction which is characteristic of herring-bone teeth.

In cutting the spiral gears and pinions they are mounted in strings on arbors, eight or ten being mounted on an arbor. The pinions are cut on an ordinary Kempsmith universal mill-

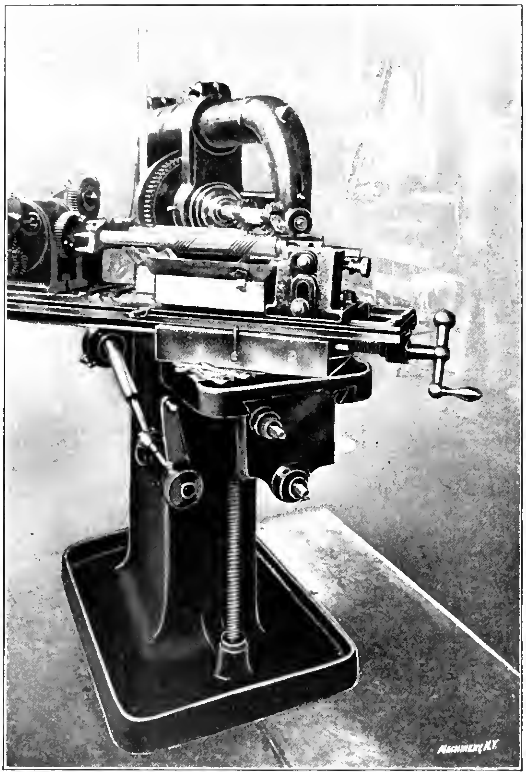


Fig. 1. Cutting two Spirals at once.

ing machine which, however, has a special attachment to the dividing head so that two arbors full of pinions may be cut at once. Attached to the side of the dividing head, as indicated in Fig. 1, is an auxiliary spindle geared to the dividing head spindle by an intermediate gear so that both will turn in the same direction, of course. The milling cutters are mounted on the machine spindle at such a distance apart as permits them to work on both arbors at the same time when the table is swung around to the required angle. It is evident that the headstock and footstock for one arbor is offset so as to stand back of similar planes of the other, thus bringing the pinion blanks in the same relative positions to the cutters.

Fig. 2 shows another Kempsmith knee-type milling machine rigged for cutting the teeth of the spiral gears. In this case the gears are attacked from the side, an attachment being provided which is bolted onto the vertical face of the frame and which carries the arbor for the cutters. A spur gear is mounted on the end of the machine spindle, and meshing with it is a spur pinion mounted on a short shaft together with a bevel gear, which latter transmits motion to the auxiliary spindle carrying the cutter. The cutter is located in line with the axis of the main spindle, so that as the attachment is set at various angles to cut the required spirals its central position is not changed. When two cutters are used for roughing, they are located, of course, at equal distances on each

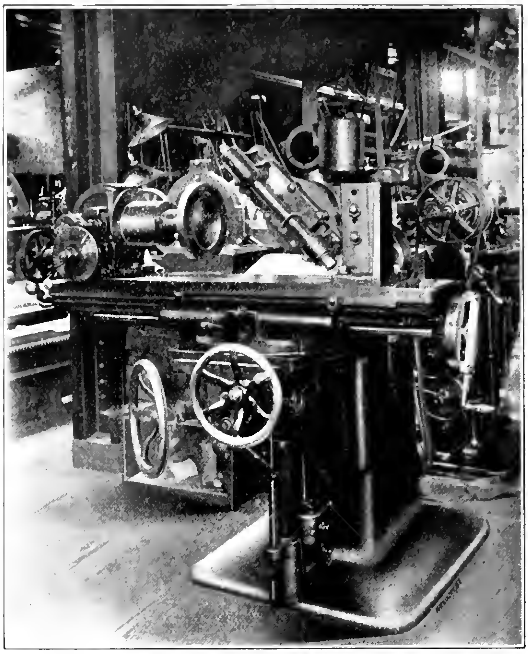


Fig. 2. Spiral Cutting Attachment for Milling Machine.

side of the central line. Fig. 2 shows a front view of the attachment and Fig. 3 a side and rear view of the machine at work cutting the teeth on a string of ten gears mounted on an arbor. The National Electric Co. has found these attachments to be very effective in reducing the cost of spiral gear cutting.

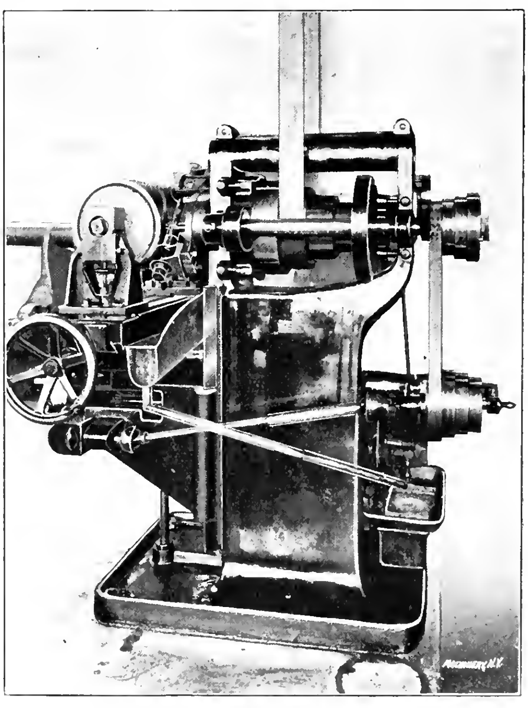


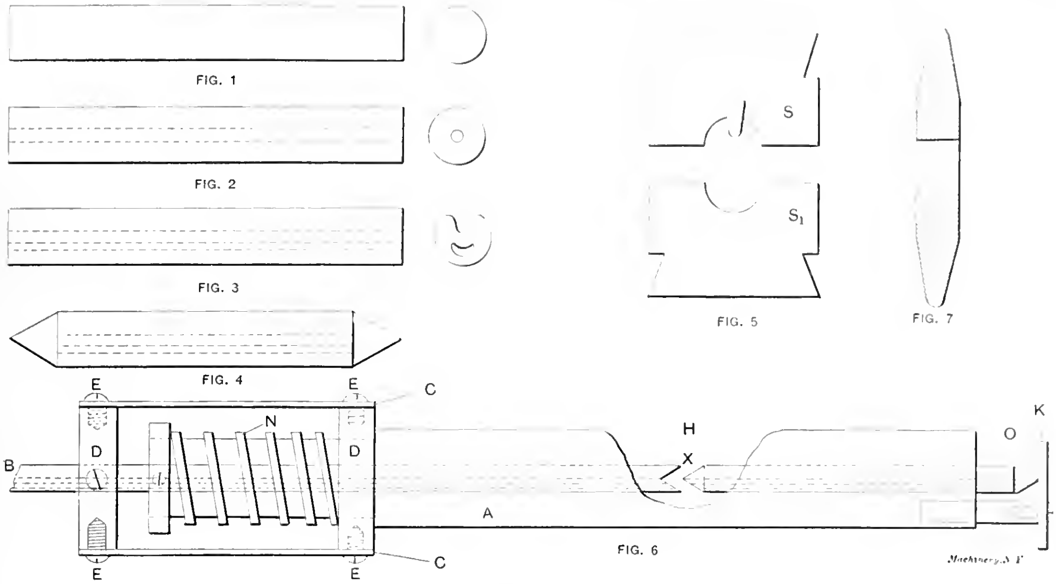
Fig. 3. Spiral Cutting Attachment in Operation.

CONSTRUCTION OF A DEEP-HOLE DRILL.

E. W. NORTON.

In the making of the type of drill shown in the illustrations we differ somewhat from that described by Mr. Eckelt in the February issue; we omit the special gage and use a plain, everyday micrometer, with the end of the spindle pointed a little less than the included angle of groove in drill, which is about 38 degrees.

In making these drills half-inch Novo stock is cut into lengths of about 4 inches (for small calibers) Fig. 1; then a hole is drilled through the center, Fig. 2; next it is heated and struck up in dies S S_1, Fig. 5, which operation forms a groove and forces the center hole, as in Fig. 2, below the center into a crescent shape, as shown in Fig. 3. It is then "pack annealed"; then both ends are pointed to 60 degrees, Fig. 4, and turned in a lathe on female centers to within 0.010 inch of finished size, this being allowed for grinding. After being pointed it is held in a milling machine vise and the groove is finished with the cutter, Fig. 7, a depth equal to one-half the finish diameter, plus 0.005 inch, minus the amount to be ground out of the groove, which varies according to the caliber of the drill and the grade of steel used. In short, the bottom of the groove must be dead central when drill is finished.



The Way the Drill is Made.

The drill is hardened two-thirds of its length, the outside and groove are ground. It is now placed in brazing fixture, Fig. 6. A is the body of suitable length with a hole drilled through it to accommodate all sizes of drills under ½-inch. B is a steel tube a little under the size of the drill; a groove is rolled the whole length of B to conform with the shape of the groove in the drill. A V-groove is milled in the end of the tube to fit the back end of the drill, which is milled off wedge shape to fit. Collars D D are bored out, one a loose fit on A, the other on B.

The drill O is placed in the end of A, then B is inserted into the other end of A. The two are brought together at the opening H, which is milled out to allow point X to come in contact with the flame. A small wooden plug is fitted into O and B to prevent the brazing stopping up the oil-hole. A small piece of silver solder is placed between the two ends; then the swinging stop K is moved into place against the end of drill O; collars P P are held together by strips C and screws E. Now B and O are brought together at X and are held firmly in place by the stop K and tension of spring N, B being held by D with the setscrew shown. With this rig the brazing of the tube and drill is satisfactorily accomplished, the device insuring correct alignment.

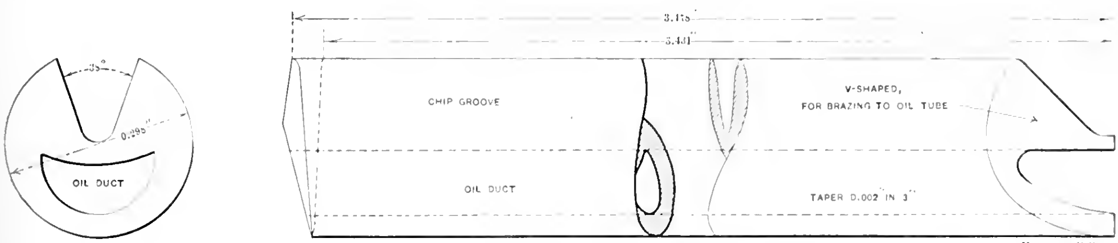


Fig. 8. Detail of Deep-hole Drill, 0.303 Caliber, Enlarged four times Natural Size.

This type of deep-hole drill is far superior to the old drill with round oil hole, it being cheaper to make, and the crescent-shaped hole allows a greater flow of oil at the cutting edge, consequently there are less "knock offs" for the driller.

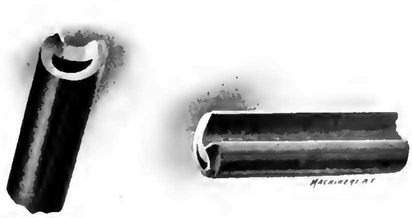


Fig. 9. Two Views of Drill.

* * *

Baldwin Locomotive Works built 220 locomotives during the month of August, and up to September 1 there had been 1,400 built during the year of 1905. This enormous production is at the rate of nearly 7 per day for each working day of the year.

ITEMS OF MECHANICAL INTEREST.

NOVEL BAND SAW SHARPENING DEVICE.

Automatic machines for filing band saws in the same manner as would be done by hand are well known, but the method employed by Mr. J. J. Rexroth, 54 Adams Street, Chicago, Ill., is one that will undoubtedly be new to most of our readers. The device consists of a wooden frame, shown on the saw table in Fig. 1, in which is mounted a tapered steel cutter resembling a tapered reamer. The teeth, however, are end cut

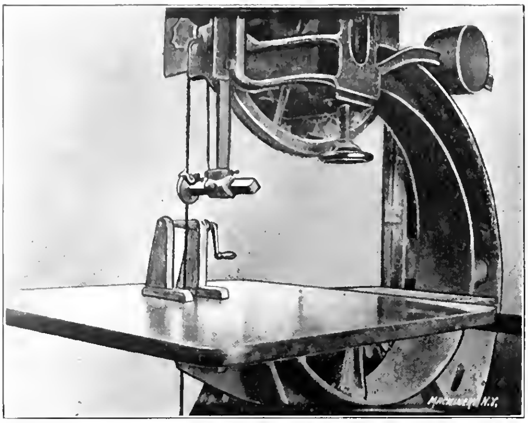


Fig. 1. Device for Sharpening Band Saw.

considerably, as will be seen in Fig. 2. The device is used by setting it on the saw table, as shown, and bringing the teeth of the saw blade to engage with the teeth of the cutter, sliding the latter sideways until the proper pitch to mesh the saw is obtained. Then by turning the crank handle so as to drive the saw upward in a direction opposite to that in which it runs when sawing, the teeth of the cutter remove thin shavings from the under face of the saw blade teeth and sharpen it with great rapidity. Running the saw around two or three

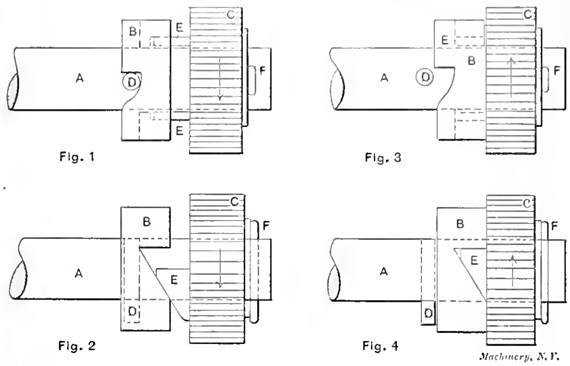
Fig. 2 Cutter for Device shown in Fig. 1.

times is enough, ordinarily, to sharpen it. The cutter tooth acts as a pinion on the saw tooth as they approach, gums the saw as it passes the center, and sharpens it as they draw apart. After the sharpening operation, it will be found that a fine feather edge has been raised on the teeth, and this is easily removed by holding a flat file against the teeth and running the saw once or twice around in the same direction. Mr. Rexroth assures us that a saw sharpened with this rig works every bit as well as when filed in the conventional manner.

NOISELESS RATCHET.

Considerable ingenuity has been displayed in the design of the ratchet mechanism of lawn mowers to make them noiseless, it having been the aim of several inventors to produce a lawn mower in which there will be an absence of the characteristic clicking noise when the machine is reversed. In one type of machine this part of the mechanism consists of a pinion containing a three-toothed internal ratchet. The pinion is loosely mounted on the cutter shaft and a hole is provided through the shaft in the plane of the three-toothed ratchet. Through this hole works a cylindrical pin made of such length that it can work back and forth through the shaft when the pinion is reversed. The moment the pinion starts in the forward or cutting direction the radial side of one of the ratchet teeth engages with the pin and drives the cutter shaft.

Another scheme is that shown in the accompanying cut in which *A* is the cutter shaft, *B* is a loose collar on the shaft and *C* is a toothed pinion. Collar *B* has two notches on the left side for engagement with the pin *D*. The left side of pinion *C* is provided with two teeth, *E*, which engage in recesses cast on the right side of collar *B*. The driving direction of pinion *C* is in the direction of the arrow, Figs. 1 and 2. From this it is evident that motion is transmitted from the pinion through teeth *E* to collar *B*, the teeth *E* driving with their inclined sides. This action, of course, forces collar *B* over to



A Noiseless Ratchet as applied to a Lawn Mower.

the left so that one of the notches on the left side are brought into engagement with the pin *D*. Reversal of movement causes the collar to slide off pin *D* and approach the pinion, thus throwing the driving mechanism out of engagement with the shaft *A*, as indicated in Figs. 3 and 4. During the reverse movement there is no reciprocating action of the clutches, hence there is no clicking sound. The moment, however, that pinion *E* is again reversed to drive, collar *B* lags behind, the result of which is that it is forced over to the left and brought again into engagement with pin *D*, thus transmitting motion to the cutter shaft. The cotter *F* takes the end thrust of *C* when driving in the cutting direction.

TABLE FOR SETTING PROPORTIONAL DIVIDERS.

The table given below was contributed by Mr. Herman Jonson, New York, who writes:

I send you herewith a copy of a page from my notebook—a table of setting for proportional dividers, which I have found useful. While I do not believe in the use of proportional dividers on exact work, that is, a drawing which must be scaled, they are all right to lay in the outlines of machinery in building plans and in catalogue work. In addition to the setting which the table gives, it also enables one to see at a glance what proportion a scale drawing is. Referring to the table we see that ⅜-inch scale is 1-32 of 12 inches (full size).

	B *A*														
		3/32″	⅛″	3/16″	¼″	⅜″	½″	¾″	1″	1½″	2″	3″	4″	6″	12″
	3/32″	1	3/4	1/2	3/8	1/4	3/16	1/8	3/32	1/16	3/64	1/32	3/128	1/64	1/128
	⅛″	1⅓	1	2/3	1/2	1/3	1/4	1/6	1/8	1/12	1/16	1/24	1/32	1/48	1/96
	3/16″	2	1½	1	3/4	1/2	3/8	1/4	3/16	1/8	3/32	1/16	3/64	1/32	1/64
	¼″	2⅔	2	1⅓	1	2/3	1/2	1/3	1/4	1/6	1/8	1/12	1/16	1/24	1/48
	⅜″	4	3	2	1½	1	3/4	1/2	3/8	1/4	3/16	1/8	3/32	1/16	1/32
a	½″	5⅓	4	2⅔	2	1⅓	1	2/3	1/2	1/3	1/4	1/6	1/8	1/12	1/24
b	¾″	8	6	4	3	2	1½	1	3/4	1/2	3	1/4	3/16	1/8	1/16
	1″	10⅔	8	5⅓	4	2⅔	2	1⅓	1	2/3	1/2	1/3	1/4	1/6	1/12
	1½″	16	12	8	6	4	3	2	1½	1	3/4	1/2	3/8	1/4	1/8
	2″	21⅓	16	10⅔	8	5⅓	4	2⅔	2	1⅓	1	2/3	1/2	1/3	1/6
	3″	32	24	16	12	8	6	4	3	2	1½	1	3/4	1/2	1/4
	4″	42⅔	32	21⅓	16	10⅔	8	5⅓	4	2⅔	2	1⅓	1	2/3	1/3
	6″	64	48	32	24	16	12	8	6	4	3	2	1½	1	1/2
	12″	128	96	64	48	32	24	16	12	8	6	4	3	2	1

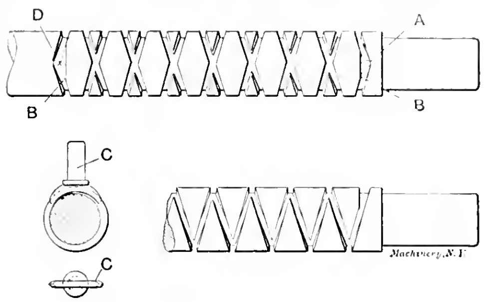
Horizontal line of figures at top represents inches per foot. Vertical line of figures at left represents inches per foot.

Example: A drawing is made ¾ inch to one foot, and we wish to make it ½ inch to one foot. Following line (*a*) ½ inch to the right till we come to (*A*) ¾ inch, we obtain a setting of 2-3 on the proportional dividers. It will be noticed that this may also be read on line (*b*) ¾ inch to the right until we come

to (B) ½ inch, and we obtain setting 1½. But as we have no setting 1½ on the dividers, we reduce 1½ to the improper fraction of 3-2, and inverting same we have 2-3 as the required setting.

CUTTING A TRAVERSE SCREW.

Mr. James F. Coyne, of East Providence, Rhode Island, sends us a description of a "traverse screw" which he has recently cut. It consists, as may be seen from the line engraving below, of a shaft which is cut with a right-hand and left-hand thread, both starting from the same drill hole A and ending in the same drill hole D. C is a guide or traveler which is adapted to move easily in the thread. If the shaft revolves continuously the traveler will be carried toward one end of the shaft. It will be noticed that at point B at each end of the screw, the thread shown by the dotted lines has been cut away



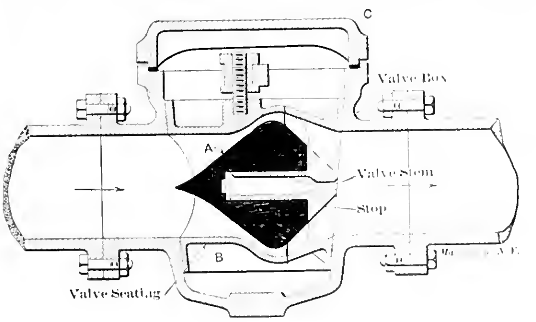
A Traverse Screw.

to form a widened recess. When the traveler reaches the end of the right-hand thread this recess gives it room to shift its position slightly and engage the beginning of the left-hand thread; which, in turn, carries it to the other end of the screw. The continuous motion of the shaft will then give a continuous reciprocating motion to the traveler C. This may be used for operating any light mechanism desired.

This device of course is not new, as the principle has been used in textile work for many years on spooling, and other machinery. There are probably few machinists, however, who have ever had occasion to cut a screw of this type, so the job is unusual enough to be interesting.

CHECK VALVE FOR UNOBSTRUCTED FLOW OF LIQUID.

The accompanying cut shows a peculiar valve box which illustrates a principle of construction employed in check valves by an English concern. The valve and seating are so designed as to give an approximately straight flow to the liquid and to make the area of the opening equal to that of the pipe in which the valve is inserted. It will be noticed that the valve A is of peculiar conoidal form, which splits the stream lines and causes the liquid to flow around it with a gently accelerated motion outward. The shape of the anterior part of the



A Novel Check Valve.

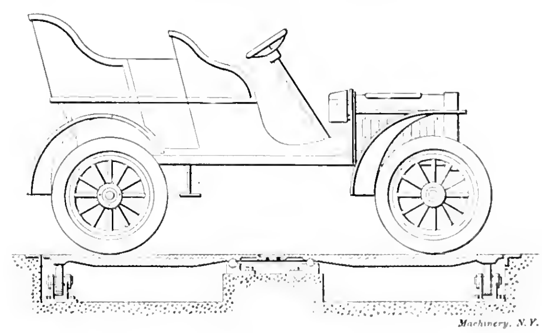
valve and seating is such that the stream lines again come together with slight eddying and cross currents. In principle the valve is the converse of the needle valve used in one form of the Pelton wheel governor. The construction of the valve box in this case is such that the valve and seating may be removed from the pipe line without disturbing the connections; this being done by removing the top, C, and pulling the conical plug containing the valve out of the case.

DEVICE FOR TESTING AIR BRAKES.

An interesting train-pipe device for testing air brakes has been patented, by means of which an engineer can test the brakes of a train and ascertain whether all connections have been properly made, and the cocks opened. The test device is attached to the last car of the train and is connected with both the train-pipe and the signal-pipe. Now, if the train-pipe pressure is raised one or two pounds above the normal ninety pounds, it causes the device to open a vent connecting the signal-pipe with the atmosphere, thus making the whistle blow in the cab. The engineer is thus informed that all the pipe connections in the train-pipe and the signal-pipe have been properly made and that a free and unobstructed connection exists in both. It is customary, of course, to test both the train-pipe and the signal-pipe of a passenger train immediately after coupling the engine to see that the trainmen have connected all the hose and opened the angle-cocks. But, while this test gives satisfactory assurance of the properly working condition of the brake and signal apparatus at the beginning of a run, it does not provide the engineer with a means of finding out whether such a condition is maintained. The closing of an angle-cock by a flying stone from the roadbed is an accident not unknown, and under ordinary conditions of service it might escape the knowledge of the engineer until the time came for a stop. If the angle-cock should happen to be closed near the locomotive the result would be that only a small percentage of the braking power would be available, thus presenting the elements for a disaster in case a quick stop was imperative.

AUTOMOBILE TURNTABLE.

Those who have to do with automobiles in garages and factories will be interested in a turntable that facilitates the handling of the cars and overcomes the unsatisfactory way of maneuvering by hand. The device shown by the illustration is manufactured by the Link-Belt Engineering Co., Philadelphia, and is essentially designed for easy operation. It consists of a cast-iron table fitted at its center with ball bearings and supported at the outer edge upon rollers. The latter are set in a concrete pit having a center pier upon which the ball-race is securely fastened. The wall of the pit is protected by an iron ring, or curb, which effectually prevents mutilation of the concrete edge. A brake is furnished and is depressed or let into the floor and top of turntable, insuring freedom from obstruction.



An Automobile Turntable.

THE VALUE OF TAIL RODS.

A suburban railway company has as a part of its equipment two 1,000-horse-power cross-compound condensing Corliss engines, the engines being alike excepting that one has tail-rods. The engine with the tail-rods has been the more economical of the two, and has cost practically nothing for maintenance during the two years it has been running. A saving in steam consumption has also been one of the features of this engine with the tail-rods, and it can be run at about 10 per cent greater capacity than the other. In the three years which the engine without the tail-rods has run, it has worn out two sets of bull rings and the low-pressure cylinder has been worn down about 1 1-16 inch.—*American Electrician.*

LETTERS UPON PRACTICAL SUBJECTS.

A WARNING.

Editor MACHINERY:

Fred was a good, practical machinist, but he was of that class which works by rule-of-thumb methods and never takes the trouble of thinking about their work unless necessary. One day the foreman told him to stay over and reseat a 6-inch valve which was on the main steam pipe. As soon as the whistle blew Fred rushed round to the boiler house and carefully shut down the main steam valve; then he sent Will, the laborer, for the reseating tools while he rigged up the platform. Will soon returned and, as the platform was ready, they took out the screws which hold the top part of the valve on; Will gave it a wrench to pull it off, but it would not come, so Fred picked up a hand hammer and gave it a sharp blow. Instantly the top part flew off, catching Will a glancing blow on the leg and with a tremendous hiss a large volume of steam blew out, severely scalding both Fred and his laborer.

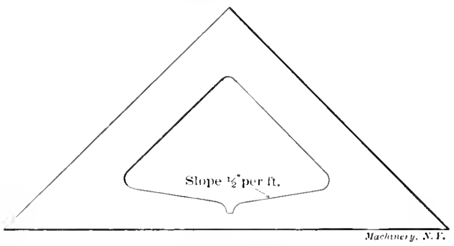
This almost fatal accident would have been avoided if the machinist had just thought for a moment about what he was doing when he shut down the main valve; that, although he had shut off the steam supply, yet the main pipe was still full of high-pressure steam which would take some time to condense. He should, of course, have opened the drip valve and blown it out before loosening the valve top. This is just one instance, but now many accidents, breakdowns, and wrecks can be traced to the similar cause—working with the hands only! GEO. P. PEARCE.

Fort Hamilton, N. Y.

TRIANGLE FOR DRAWING I-BEAM SECTIONS.

Editor MACHINERY:

The sketch shows an alteration to a triangle which makes the drawing of the sections of I-beams and channels much easier than the ordinary way. The slant is that of the flanges



A Handy Triangle.

of the standard rolled sections, *i. e.*, 16 2-3 per cent or 2 inches per foot. This may be of service to those draftsmen who have some structural work to do, but not enough to warrant the purchase of a special triangle. ROGER DEL. FRENCH.

Worcester, Mass.

KEEPING CUTTING TOOLS SHARP.

Editor MACHINERY:

The extreme importance of having cutting tools kept sharp is now generally understood. Like many other questions in shop practice, the truth of which are known, it is not usually capable of being actually demonstrated. The accompanying diagram shows the turning moment for three different 1½-inch drills each at three speeds, but at one feed. It tabulates the result of a few out of many experiments made under Dr. Nickolson, by a machine testing class of which the writer was a member. In the case of experiments marked *A*, through the edge chipping, the drill was sharpened before starting the third hole, and the results lie on a straight line. In the other cases the drills did the three holes without any grinding between the tests. In both cases the turning moment for the last hole was high above the probable curve. It should be noted that after all experiments the edge of the drill was not, so far as could be seen by the naked eye, the least dulled. This deterioration was not confined to any make or kind of drill, *B* being of English high speed steel and *C* a low carbon drill of American make. The work of the drills, drilling through about 4 inches of medium steel at .01-inch per revolution, was not by any means severe. In fact, judging by the amount of work done and the appearance of the drills, where the grinding was left to the option of the workmen, in the majority of cases they would not have been sharpened.

It may seem as if the slight increase in moment required is not important. Judged simply as a loss of power, it could be

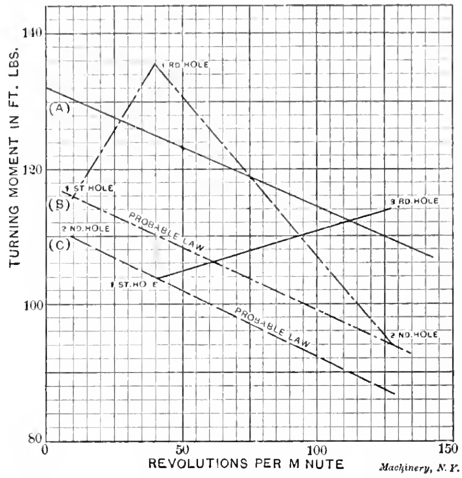


Diagram showing the Effect that a Dull Cutting Edge has on the Action of the Twist Drill.

neglected. But all the extra power goes toward heating the work and the tool, and produces many undesirable results. It would seem from the foregoing that tools should be ground after doing a certain amount of work whether the appearance suggests it or not. This is in accordance with the best practice to-day. H. T. MILLAR.

Manchester England.

THE PROPORTIONS OF HAND TAPS.

Editor MACHINERY:

When using hand taps it has occurred to me that hand taps in sets of three are not made by manufacturers in such a manner as to give fair portions of work for each tap to do. All the taps I have ever been able to secure have been made in the same manner, *i. e.*, by giving a different length of chamfer to the different taps in a set; otherwise all three taps have had the same diameter in the angle of the thread and the same outside diameter. In my case, having had machine steel strips

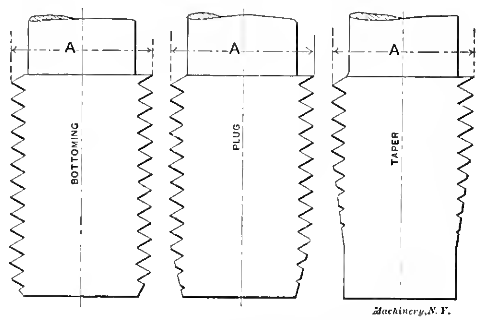


Fig. 1. Set of three Taps, as usually Made.

to tap holes straight through, I have found that the second and third tap had no work to do whatsoever, and as a consequence I have discontinued buying them. Now, the difficulty has been that the first tap (taper), having to do all the work for the tapping out of the hole, is put to altogether too severe a strain, and I have had much trouble about the taps breaking. As this became rather expensive and as I had an idea that I could overcome the difficulty, I made up a set of three

taps so proportioned in regard to outside diameter as to give to each tap a fair amount of the work to do. This set of taps I have now used with entire satisfaction for a time during which I ordinarily would have had to buy and break at least a dozen regular taper taps, and as these taps are still as good as new there is no telling how long they are going to last.

No. of Threads per inch.	V-THREAD.			U. S. S THREAD.		
	Depth of Thread.	$\frac{4}{3}$ of Depth.	$\frac{1}{2}$ of Depth.	Depth of Thread.	$\frac{4}{3}$ of Depth.	$\frac{1}{3}$ of Depth
3	.28868	.38490	.14434	.21651	.28868	.07217
3½	.24744	.32992	.12372	.18558	.24741	.06186
4	.21651	.28868	.10825	.16238	.21648	.05412
4½	.19245	.25660	.09622	.14434	.19244	.04811
5	.17321	.23092	.08660	.12990	.17320	.04330
5½	.15746	.20992	.07873	.11809	.15744	.03936
6	.14434	.19244	.07217	.10825	.14432	.03608
7	.12372	.16496	.06186	.09279	.12372	.03093
8	.10825	.14432	.05412	·08119	.10824	.02706
9	.09623	.12828	.04811	.07217	.09622	.02405
10	.08660	.11544	.0433	.06495	.08660	.02165
11	.07873	.10504	.03936	.05905	.07872	.01968
11½	.07531	.10040	.03765	.05648	.07528	.01882
12	.07217	.09620	.03608	.05413	.07216	.01804
13	.06662	.08880	.03331	.04996	.06660	.01665
14	.06186	.08248	.03093	.04639	.06184	.01546
16	.05413	.07216	.02706	.04059	.05412	.01353
18	.04811	.06412	.02405	.03608	.04811	.01202
20	.04330	.0577	.02165	.03248	.04328	.01082
22	.03936	.05248	.01968	.02952	.03936	.00984
24	.03608	.04808	.01804	.02706	.03608	.00902
26	.03331	.04440	.01665	.02498	.03328	.00832
27	.03208	.04276	.01604	.02406	.03208	.00802
28	.03093	.04124	.01546	.02320	.03092	.00773
30	.02887	.03848	.01443	.02165	.02884	.00721
32	.02706	.03608	.01353	.02030	.02704	.00676
34	.02547	.03396	.01273	.01910	.02544	.00636
36	.02406	.03208	.01203	.01804	.02404	.00601
38	.02279	.03036	.01139	.01709	.02276	.00569
40	.02165	.02884	.01082	.01624	.02164	.00541
42	.02062	.02748	.01031	.01546	.02060	.00515
44	.01968	.02624	.00984	.01476	.01968	.00492
46	.01883	.02508	.00941	.01412	.01880	.00470
48	.01804	.02404	.00902	.01353	.01804	.00451
50	.01732	.02308	.00866	.01299	.01732	.00433
52	.01665	.0222	.00832	.01249	.01664	.00416
54	.01604	.02136	.00802	.01203	.01604	.00401
56	.01546	.02060	.00773	.01160	.01544	.00386
58	.01493	.01988	.00746	.01120	.01492	.00373
60	.01443	.01924	.00721	.01083	.01444	.00361

Having had such success with my taps I have laid out a diagram and figured a table giving how much less in outside diameter the first and second tap should be made than the finishing tap in order to secure a set of taps giving good results.

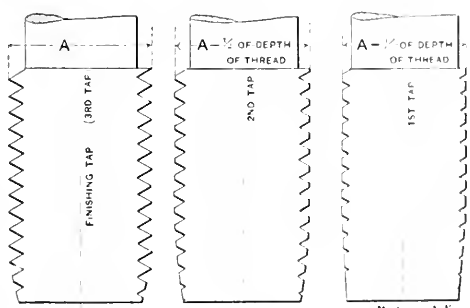


Fig. 2. Proposed Arrangement for Set of three Taps.

If we now first consider the diagram of the 60-degree V-thread, it will be noticed that the outside diameter of the first tap will equal the outside diameter of the finishing tap minus 4-3 of the depth of the thread; the outside diameter of the second tap will equal the outside diameter of the finishing tap minus ½ of the depth of the thread. It may occur to some one that the first tap is more than necessarily reduced in diameter, and that this tap has not as much stock to remove as the second tap, but considering the shape of the thread, it can easily be calculated that the area *A B C D* is larger than the area *C D E F*; in fact, the former area (*A B C D*) is in proportion to the latter (*C D E F*) as 9 to 6. It is obvious that the first tap ought to remove more stock than the second, because the top of the thread in the first tap has a smaller or less leverage than the top of the thread in the second tap. The finishing tap again, according to the diagram, only removes 1-16 of the whole area (*A B G*) of the thread. The reason for apportioning such a small amount to the finishing tap is to secure a nicely finished threaded hole.

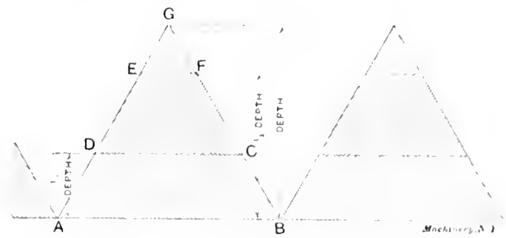


Fig. 3. Diagram showing Depth of Cut for V-thread.

Although I did not in the first place make my taps with any difference in the diameter of the angle of the thread, I would suggest that the first and second taps be made 0.001 or 0.002 inch smaller in the angle of the thread than the finishing tap. This will leave a very slight amount of stock to be removed by the finishing tap all over the thread, thus giving a nicer and smoother finished threaded hole than could otherwise be obtained.

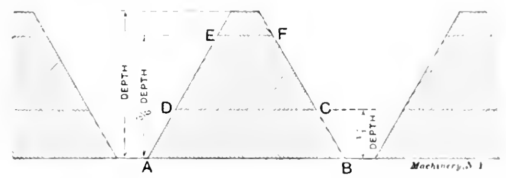


Fig. 4. Diagram showing Depth of Cut for U. S. Standard Thread.

If we now again consider the U. S. standard thread it will be found that the outside diameter of the first tap will equal the outside diameter of the finishing tap minus 4-3 of the depth of the thread; the outside diameter of the second tap will equal the outside diameter of the finishing tap minus 1-3 of the depth of the thread. The areas *A B C D* and *C D E F* will in this case be in the same proportion to one another as 31 is to 21 (10 to 7 approximately). A. A.

HINTS ON ESTIMATING THE COST OF WORK.

Editor MACHINERY:

It is very convenient for the estimator to have a list of the speeds and feeds of the machines in his shop. By means of this he can find the approximate time required for a given operation. Take, for instance, a drilling job. If we assume a proper speed and feed for the size of drill to be used in the given material, it is easy to calculate the time required to drill one hole. Of course the time required to "rig up" for the job, and the time used in removing the drill and starting a new hole, must be estimated from previous jobs.

In drilling some cast steel flanges containing two rows of 1 5-16-inch holes, 44 in each row, a Novo twist drill running 80 revolutions per minute with 1-64-inch feed was used in a universal radial drilling machine; a jig was provided to locate the holes. At this speed a drill would go through 1¼ inch per minute. The flanges being 1¾ inch thick, the drill would go through the flange in about 1½ minute. On a radial drill with a jig, the drill can be removed and started in a new hole in one minute, which, added to the time required for actual drilling, makes 2½ minutes on each hole. Hence about 22 holes per hour is about as good as can be done in actual practice under the conditions named.

In drilling a brass plate such as a condenser tubesheet, the drill can generally be run as fast as the machine will go. In a job of this kind 600 ¾-inch holes can be drilled through 2 inches in 10 hours.

With modern high-speed steel for lathe tools, the limit is

usually with the work, as to speed, and, of course, a long slender shaft will not stand as fast speed and feed as a short and stiff one. The sketch shows an axle for an electric car which I recently turned up. For stock I was furnished with a bar of 5¼-inch steel sawn from a long bar with a cold saw.

Centering, squaring ends and taking off chuck and back rest occupied about two hours.

I found the piece to "run out" 3-16 inch in the middle, so one roughing cut would not leave this part running true. Using a Novo tool and running 70 R. P. M. with a feed of 18 turns per inch, the tool turned 1 foot in 4 minutes; grinding tool, etc., made the time for first chip ½ hour. For the second cut the speed was 80 R. P. M., and with same feed 1 foot was turned in 2½ to 3 minutes. Both cuts occupied about one hour.

Roughing out ends with the same speed (80 R. P. M.) took ½ hour each, and water finishing them at 36 R. P. M. took 1 hour each.

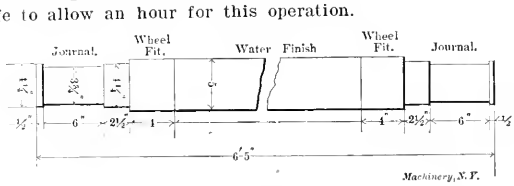
I left the wheel fits rough, and water finished the middle at 16 R. P. M. or 1 foot in 15 minutes or 1 hour for 4 feet. A shorter shaft could have been run faster, but this being so long and slender would have chattered and left the work rough.

The whole time for turning axle was:

Centering and squaring ends..........	2 hours
Roughing out (2 cuts)................	1 hour
Roughing out ends at ½ hour..........	1 hour
Finishing journals...................	2 hours
Finishing middle.....................	1 hour
Total	7 hours

This is not a "record breaker," but about the average time for a job of this kind, and a safe basis for the estimator to figure from.

A shaft with less stock to be removed would ordinarily have to be straightened, and no rule can be given for this, but it is safe to allow an hour for this operation.



An Electric Car Axle.

It is a good plan for the estimator, or for the ambitious mechanic who wishes to be promoted to that position, to keep a record of his time on various jobs and the time of others on important work if possible. This with a rough sketch will be of great value to him in "figuring on work."

One good point about the "piece work" system, so called, was that it trained mechanics to note the cost of doing work. It is not a safe rule that if we know the time for a given piece of work to assume that a piece twice as large will require twice the time. Neither is it safe to surmise that it will take twice as long to machine two pieces as it would one. Once I had twenty-five shafts to turn. It took me eight hours to turn the first and after that I turned three a day.

The time required to do a job in many cases depends on "the man behind the lathe," so that it is not safe to estimate from the most rapid workman's time, nor is it safe to use the other extreme, but a fair average must be found.

Portland, Me. H. K. GRIGGS.

REVERSING LEVER PROBLEM.

Editor MACHINERY:

The accompanying sketch shows a practical reversing lever problem diagram. Its solution requires considerable time as well as a knowledge of mathematics. Having occasion recently to solve the problem I reduced it to its simplest form—an arithmetical formula—and made a memoranda of it for future use. The thought occurred to me that it would probably be serviceable to many of your readers also.

We have given, the distance, c, between two center lines of motion one which is of a length, a, and the other of a length, b. The center of the radii R and r lies in the perpendicular bisector, which represents the lever in mid-position, and this point, of course, is the fulcrum of the lever. Then the distances x and y on the perpendicular bisector of the horizontal center lines of motion are derived thus:

$$x = \frac{a\,c}{a + b}$$

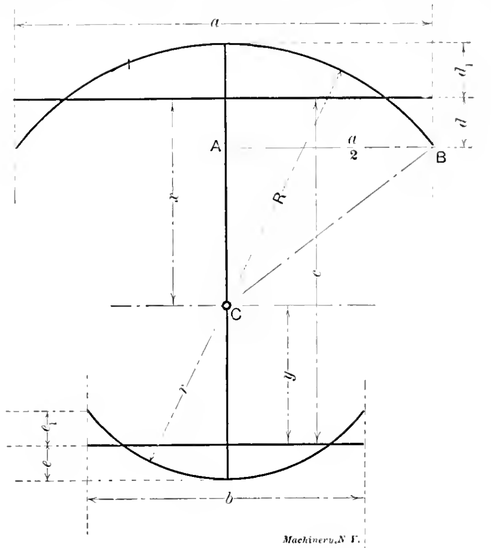
$$y = \frac{b\,c}{a + b}$$

From which R is found by formula:

$$R = \frac{a^2}{16\,x} + x, \text{ and}$$

$$r = \frac{b^2}{16\,y} + y,$$

which are the proper dimensions for a theoretically correct reversing lever; that is, one which vibrates equally each side



A Reversing Lever Problem.

of the center line and the arc of which passes as far above the center line of motion as it does below it, or so that $d = d_1$ and $e = e_1$. FRANKLIN H. SMITH.

Buffalo, N. Y.

Mr. Smith did not give the derivation of the formula in his letter, but as same will doubtless be of interest to those desiring to use it we append it herewith. It is apparent from the conditions of the problem and the diagram that $R - d_1 = x$; also $d = d_1$. Drawing the radius $B\,C$ and $A\,B$ parallel to a we have a right triangle in which $\overline{A\,C}^2 = \overline{B\,C}^2 - \overline{A\,B}^2$.

But $B\,C = R$, and $A\,B = \frac{a}{2}$. Hence

$$\sqrt{R^2 - \frac{a^2}{4}} + d = x. \text{ Adding both values of } x$$

$$R + \sqrt{R^2 - \frac{a^2}{4}} = 2\,x. \text{ Simplifying}$$

$$R = \frac{a^2}{16\,x} + x$$

In the same way it can be shown that

$$r = \frac{b^2}{16\,y} + y.$$

A COMBINED CLUTCH AND LOOSE PULLEY.

Editor MACHINERY:

The type of loose pulley shown in the sketch has long been known as the best type for use in planing mills, or other woodworking establishments, where the machines are run at a high velocity. The tight pulley is placed on the first mover or lineshaft, with the loose pulley placed beside it, but instead of the loose pulley running on the shaft it runs on a

sleeve cast on the hanger. The sleeve is bored large enough for the shaft to pass through without touching it, being, say, ⅜ inch larger. Neither a collar nor a shoulder is required on the sleeve in the combined loose pulley and clutch, as the clutch collar and lever keep the loose pulley in place. When the belt is on the loose pulley, the machine, the belt, and the loose pulley are all idle. Consequently there is no wear, and no attendance is required.

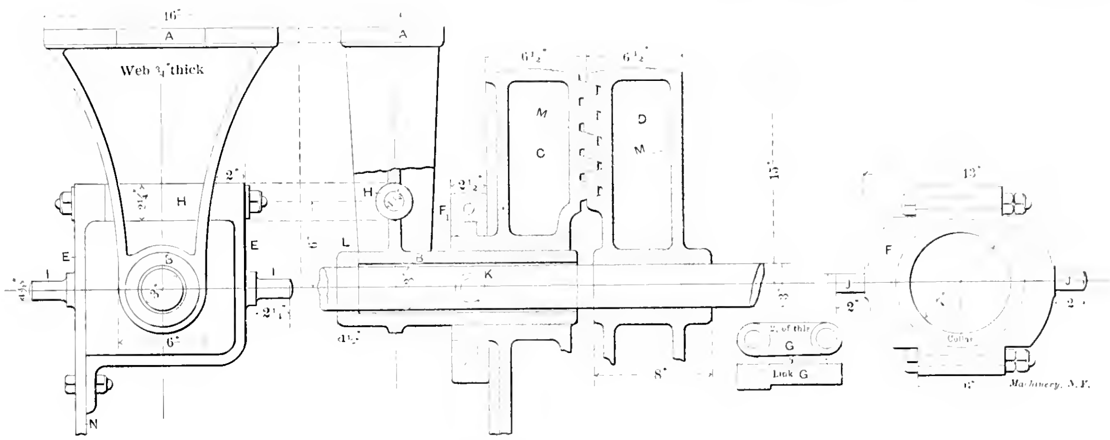
To start a machine when the clutch is omitted, take hold of the belt and put it in motion, which is easily done in the case of woodworking tools when the feed is thrown off and the machine not cutting. The belt being thus put in motion, it is easily moved on to the tight pulley by the belt shifter which is of the ordinary type, consisting of a sliding bar with verticals on each side of the belt on the side of the pulley toward which the belt runs. To stop the machine shift the belt on to the loose pulley by the belt shifter and the entire system—machine, countershaft and loose pulley and belt—is idle and all wear stops. The loose pulley runs only while the belt is being shifted. It will readily be seen that such a pulley needs but little oil, say a few drops once a month, and if the device mentioned by "Bristol" in the May issue of MACHINERY were used in the bore of the pulley it would never need oil.

This device is admirable where there are several lines of shafting all driven from the main line or first mover; any one or any number may be idle and the rest of the mill running for any length of time, and no wear takes place on any of the loose pulleys. It may be used in the driving of other machinery, which requires the full power to put it into motion, but in order to do this it would require the combined clutch and loose pulley like the device shown in the drawing which consists of a hanger and sleeve A, the latter bored to let the line shaft through as heretofore mentioned and turned to fit the loose pulley easily. The part of the hanger which is bolted to the ceiling or floor should be planed square with the sleeve. C is loose pulley with clutch grooves on one side. D is a tight pulley, also made with clutch grooves on one side, and is fastened to the lineshaft K. E is a wrought iron lever for throwing the clutch in and out; the fulcrum pin passes through the boss H on the hanger. F is a loose collar which fits on the collar turned on the hub of the loose pulley C, and is for throwing the clutch in and out. G is one of two links connecting pins I on the lever and J on the collar. The dotted circle K shows the position of the pins when the collar is in place; this collar and its pins are of cast steel. L is a collar secured to the shaft by conical point setscrews to keep the hanger from springing out of place. The dotted lines M M show position of small oil pipes for oiling clutch faces, which is required occasionally to prevent sticking.

The belt being on the loose pulley, the machine is started by throwing in the clutch by the lever N. The belt is then shifted onto the tight pulley, and the clutch faces moved apart to prevent wear. To stop, simply shift the belt as previously described. A separate starting lever and a belt-shifter are, of course, required.

So thoroughly do I believe in this type of loose pulley because of my own experience with it, I would not fear to build and erect them (if I had a foundry and machine shop) under a warranty against all natural wear for ten years.

Syracuse, N. Y. C. E. MINK.



A Combined Clutch and Loose Pulley.

ESTIMATING THE COST OF MACHINE WORK.

Editor MACHINERY:

A matter to be observed when estimating for a job is to have the estimation in such form as is easily compared with the cost account when the work is completed. While in Mr. Webster's method of tabulating—described in the July issue—the operation and quality of labor to be used on each seem very good, his method of adding the shop charges might be improved. By shop charges I mean the items of shop superintendence and part of the 33 1-3 per cent added to the account at the end.

The cost of an operation which involves the use of a machine should be estimated with regard to the interest and depreciation on the outlay. A $1,500 machine even when worked by cheap labor is perhaps as expensive per hour as a toolmaker working without a machine. It is quite conceivable, indeed it is very probable that some operations need more supervision than do others. Therefore it is natural that each operation should bear its share of the shop charges in proportion to the amount of capital which, so to speak, is being used at the time and the relative amount of "non-productive labor" it entails. This can not be gotten exactly, but the general run of shop operation could be divided into seven or eight classes, each with its different shop rate. The only alteration in the given case would be another column in which the shop rate—which would generally be independent of the quality of the labor—would be entered. While on the subject of labor, does not this job need rather a high percentage of boys—65?

Manchester, England. H. E. MILLAR.

[The percentage of boys' labor in time is 71.5 per cent, and in cost 52 per cent.—EDITOR.]

TO CHANGE GEAR RATIOS WHEN THE NUMBER OF TEETH AND CENTER DISTANCE IS FIXED.

Editor MACHINERY:

A problem in gearing which was quite out of the ordinary came to my notice some time ago. Perhaps the problem and its solution may interest some of your readers. A machine had been built with two of its shafts a certain distance apart and each running with equal number of revolutions. In the course of time it became necessary to reduce the number of revolutions of one of the shafts. It was desired to use the same pitch gears and to keep the same center distance, so the facts were that we had a certain number of teeth to utilize and desired a certain number of revolutions of each of the two gears. Therefore the problem was to obtain the number of

teeth in each gear. This was obtained by dividing the known number of revolutions by the desired number of revolutions per minute, and adding one to this quotient. Then divide the whole number of teeth in both of the equal gears by the number obtained and the quotient will be the number of teeth in the driving gear. This number taken from total number of teeth will show the number of teeth required in the driven gear. Example: Assume a driving shaft running with 100 R. P. M. and that it is desired to revolve the driven shaft 60 R. P. M.; total number of teeth to be utilized is 120. $\frac{100}{60} = 1.66 + 1 = 2.66$. $\frac{120}{2.66} = 45 =$ number of teeth in driving gear. $120 - 45 = 75 =$ number of teeth in driven gear.

If it had been desired to increase the number of revolutions in the driven instead to decrease them the respective tooth numbers would have been obtained by dividing the required number of R. P. M. by the R. P. M. of the driving gear and adding one to this quotient. Then, dividing the total number of teeth to be utilized by the number already obtained, the resulting quotient would be the number of teeth in the driven gear. This number taken from total number of teeth will show the number of teeth required in the driving gear. Example: Assume a driving shaft running with 100 R. P. M. and that it is desired to revolve the driven shaft 150 R. P. M. Total number of teeth to be utilized is 120. $\frac{150}{100} = 1.5 + 1 = 2.5$. $\frac{120}{2.5} = 48 =$ number of teeth in driven gear. $120 - 48 = 72 =$ number of teeth in driving gear. C. E. Josselyn.

Bridgeport, Conn.

A FEW ITEMS WHICH HAVE HELPED ME.

As I draw circles with the compasses, where the centers are not well defined I draw a little free hand circle around the center. Then I don't have to hunt for the centers when inking.

If I have to make a drawing on a scale of 3 inches to the foot, as often happens, and have no scale handy that reads to this proportion, as also often happens, I look at it as ¼ inch = 1 inch. That is, suppose I have a measurement of 7⅝ inches. I read it as 7 quarter inches which I count off on my rule and ⅝ of a quarter inch. As most scales are divided at least as close as 1/16 inch this latter will be half way between ½ inch and ¾ inch, which are represented by the ⅛-inch and 3/16-inch marks on the scale. If I have to draw a circle of a given diameter to quarter size I use the same means to get the radius except that I read of ⅛-inch divisions and fractions of eighths instead of quarters and thus get the radii direct. All of which is a lot easier, and more likely to be correct than figuring it out.

I have to do drafting at different times in a number of places. We all know that the usual size of instrument case is not convenient to carry in the pocket, for men are apt to have steady use for about all the pockets they are allowed. After trying for some time I ran across a salesman who was willing to make up a set to suit me, of Riffler instruments which takes up little room and fills the bill. It consists only of a 5½-inch compass with the usual pencil and pen and lengthening bar. These are slip-joint instruments so changes can be made instantly. If I want to draw circles of 1/16 inch or even less radius I can do them just as well as with a bow instrument for there is a hair-spring attachment. If I want to use a ruling pen the lengthening bar makes a nice handle for the pen. By changing the lead for a compass needle I have a hair-spring divider, though when I get rich I am going to get an extra pencil holder and keep a point in it for such use. A short scale completes the outfit.

When I am going where I have no drawing-board I can usually buy a molding board such as "mother used to use," which makes a good board when two edges are planed off at right angles. They cost only a few cents so if one warps you can buy another. It is surprising how much work can be done on small sheets if you only get used to it. As for having two edges at right angles I am still old-fashioned enough to do my penciling with the triangle but I like to ink all vertical lines with the T-square. It is a great time saver over fooling with a set-square.

A T-square with a detachable head fastened by a dove-tail piece on the blade is a handy thing for traveling to say nothing of its being easily trued up.

How do the rest of the boys feel about doing designing by the hour; not where you have a steady job but where you undertake a certain job? The quicker you think up a scheme and the fewer futile attempts you make the less you get. On the other hand very few people can be persuaded to agree to pay a price for a lump job that makes it safe for the designer. Why should a designer do his work on a different basis from a lawyer or a doctor who charges what he considers his services worth? There would be the same check on his charges as on theirs for unless he pleased his clients there would be few new ones coming. Entropy.

GROUPING MACHINERY'S DATA SHEETS.

Editor Machinery:

The data sheets published with Machinery are a great aid in machine design. We have a number of sets of them in this drawing room, and in order to find the required information

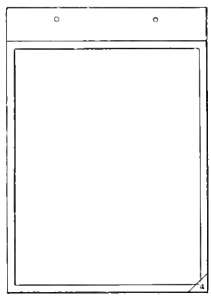
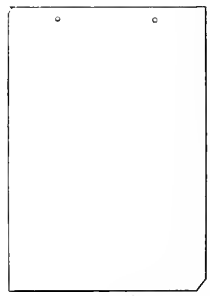


Fig. 1.



Machinery, N.Y.

Fig. 2.

quickly I have arranged the sheets in groups in a binder according to an index of which I send you a copy herewith. On one sheet of each group, I mark the group number in the lower corner. On the other sheets I cut off the corner, Fig. 1. By

MACHINERY'S DATA SHEETS—INDEX.

1.	Mathematical Tables.	29.	Steam Engines.
2.	Weights, Measures.	30.	Steam Boilers.
3.	Mechanics.	31.	Combustion Engines.
4.	Materials.	32.	Electric Power.
5.	Water.	33.	Machine Tools.
6.	Air, Gases.	34.	Cranes and Hoisting Machinery
7.	Steam.	35.	Hydraulic Machinery.
8.	Keys, Wedges, Pins, Etc.	36.	Pumps.
9.	Nuts, Washers, Screw Threads, Bolts.	37.	Heating and Ventilating.
10.	Rivets, Riveting Data.	38.	Blowers, Compressors.
11.	Spikes, Nails, Wire, Etc.	39.	Building Work.
12.	Chain gearing, Tooth-, Friction-.	40	Machine Shop Data.
13.	Wire Rope, Belts, Pulleys, Sheaves.	41.	Drawing Room Data.
14.	Brakes, Ratchet Gears, Levers, Handwheels.	42.	Electrical Data.
15.	Journals, Axles, Shafts.	43.	
16.	Shaft Collars, Couplings, Clutches.	44.	
17.	Bearings.		
18.	Springs.		
19.	Chains, Hooks, Links.		
20.	Chain Wheels, Drums, Etc.		
21.	Cylinders, Stuffing-boxes.		
22.	Pistons, Plungers.		
23.	Crossheads, Guides.		
24.	Flywheels, Governors.		
25.	Cast Iron Pipes, Fittings.		
26.	W. Iron, Steel Copper, Etc. Pipes and Flanges.		
27.	Pipe Fittings.		
28.	Valves, Cocks, Etc.		

Size of Index Sheet 6 x 9 inches.

this arrangement I can at once find the required group of sheets. In order to get all the sheets uniform I use a cardboard template for punching the holes and trimming the corners as shown in Fig. 2. K. B.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO PREVENT BABBITT FROM EXPLODING.

To prevent babbitt from exploding and to insure good bearings, put two or three teaspoonfuls of kerosene oil into the box before pouring the babbitt. H. K. Griggs.

Portland, Me.

TO REPAIR A FEED OR OTHER WATER PIPE TEMPORARILY.

To effect a temporary repair of a cracked water pipe mix a moderately stiff putty from red and white lead, with boiled linseed oil, and work into it some hemp chopped into short lengths; lay it over the crack in a moderately thick mass and wrap some strips of canvas tightly around the pipe overlapping both ends of the crack, and finish by sewing marline hard over the strips of canvas. James A. Pratt.

Howard, R. I.

HOW TO SET A PLAIN DIE IN A PUNCH PRESS.

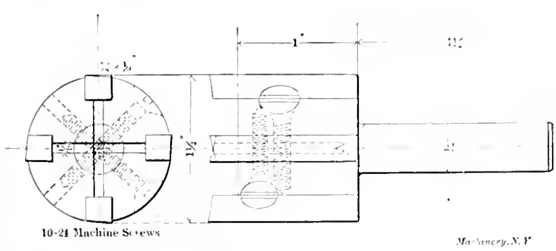
To set a plain die in a punch press adjust the male portion of the die so it will not go more than 11-32 inch below the surface of the female die; then twist the female die around to the right as far as it will go; mark it with reference to some stationary part of the press, and then turn it to the left, again marking in the same way; then turn the female die one-half the distance between the two marks, and now screw it down by tightening the screws alternately, being careful not to move it. In this way it is easy to get the space divided up accurately between the two parts of the die.

Winnetka, Ill. Frank Pavlik, Jr.

"HURRY UP" END MILL.

Editor Machinery:

I herewith enclose sketch of a "hurry up" end-mill which I made recently, and it is certainly a winner. The body and shank is made from tool steel, one piece, and is slotted well back to the shank. The cutters are made of "Rex" steel, ground off on the sides to fit their seats in the body, and held by two 10-24 machine screws. The cutters may be ground by



hand on an emery wheel, then placed in position and the table raised, thus pushing the cutters up so the cutting ends are even. The binding screws are tightened as before, which, if done with a little care, adjusts the ends very close. This cutter, of course, was designed for the vertical milling attachment. L. E. Murray.

Syracuse, N. Y.

HARDENING A SCRATCH AWL.

After a great deal of experimenting I have discovered a most effective way to harden the points of scribers (or scratch awls as they are often called) so they will be hard and at the same time tough enough to "stand the racket." Here it is:

Heat the point of the scriber over an alcohol lamp or bunsen burner, leaving the extreme point out of the flame to avoid the danger of overheating. Hold a thin piece of ordinary soap in the hand over a cup of water, and when the scriber has reached a nice "cherry red," push it down through this soap into the water below. Draw the temper to a very dark straw. R. A. Lachmann.

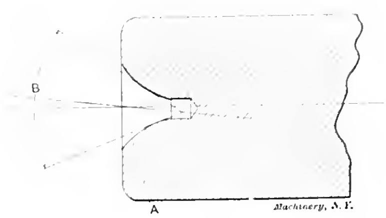
Chicago, Ill.

TO SUCCESSFULLY COLD WATER ANNEAL TOOL STEEL

To successfully "cold water anneal" tool steel, I find that the following method gives by far the best results of any of the various methods I have tried: The steel is heated and allowed to cool down in the usual way. Before being immersed in the water it is smeared with a bar of cheap alkali soap; it is then dipped into a pail of preferably luke-warm soap water, and quickly withdrawn, after which it is again smeared with the soap and dipped again and then allowed to cool. If a large piece is to be annealed, repeat the above until cool, this being necessary as a large piece retains its heat longer than does a small piece. Care should be taken not to get any soap or soap water in the tank containing the solution used for hardening. C. F. Emerson.

CURVED SIDE COUNTERSINK IN MANDREL FOR TAPER LATHE WORK.

The accompanying sketch of the end of an arbor shows a way of countersinking which works much better than the standard angle of 60 degrees (shown by the line *B*) on taper work that is turned on a lathe without a taper attachment. The dotted lines show, exaggerated, the effect that throwing



over the tailstock has on the fit between the centers of the lathe and the arbor. The curved side countersink, of course, is not recommended for straight work, or for use on a lathe provided with a taper attachment. M. H. Ball.

Watervliet, N. Y.

TO START A THREADING DIE.

We all know how easy it is to tap a hole out of square but many of us don't realize that in running a die over a piece without the aid of a die holder made to fit in the tail stock spindle of a lathe, it is an easy matter to cut the thread out of line, as shown in Fig. 1.

FIG. 1

FIG. 3

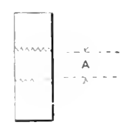


FIG. 2

Machinery, N.Y.

In order to eliminate this possibility I generally turn down the front end of piece to be threaded (leaving the piece sufficiently long so it can be cut off if desired) so that the die can just push over without shake; in other words, I turn the end to the root diameter of the die as shown in Fig. 2 at *A*. Fig. 3 shows how nicely the die starts true by using this method.

Chicago, Ill. R. A. Lachmann.

* * *

An exchange says that in hard soldering or brazing with borax direct, difficulty is encountered from the great bubbles formed by the salt, which easily breaks away from the surfaces to be soldered or brazed. Another objection is that the parts must be carefully cleaned each time prior to applying the borax. It is advised that instead of using borax to use its component parts—boric acid and sodium carbonate. The heat acting on these causes them to combine in such a manner as to produce an excellent flux without the objectionable features of borax.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

TO ANNEAL STEEL OR IRON.

Smear the iron or steel with tallow, and heat slowly in a charcoal fire until it is a dark red. Allow it to cool itself. This method is all right for very hard tool steel.

Schenectady, N. Y. R. B. CASEY.

IRON CEMENT.

For plugging holes in castings a good cement is made from 80 parts of sifted cast iron turnings, 2 parts of powdered sal-ammoniac, and 1 part sulphur, made into thick paste with water fresh for use. DAVID MELVILLE.

Detroit, Mich.

ATTACHING CLOTH TO IRON.

Heat the iron so it will be just too hot to touch with the bare hand, put on a coat of red shellac; have the cloth already cut, applying it quickly, and press firmly in place.

Howard, R. I. JAMES A. PRATT.

DRILLING COMPOUND.

A good drilling compound is made by adding 1 pound common soda to 4 quarts water, and 1 pint machine oil. Let stand for about one hour and it will be ready for use. This will not rust the machines and is clean to work with.

Winnetka, Ill. FRANK PAVLIK, JR.

RUST PREVENTATIVE.

To make a mixture that will prevent hardware and machinists' tools from rusting, take one-half pint of Demar white varnish, and mix it well with one gallon of turpentine; use as a wash. When the polished surfaces are thoroughly covered with a thin coat of the varnish it will show scarcely any, but will preserve the polish for years, if it is not scraped off with something very hard. H. E. WOOD.

Pearl River, N. Y.

DIE SINKERS' IMPRESSION WAX.

In the following I give two receipts for die-sinkers' impression wax. In the first the exact proportions of some of the ingredients are not given, but the maker can use his own judgment, gradually adding more of one than the other until the right consistency is obtained. 1. Beeswax, 6 parts; white wax, 1 part; a small quantity of cornstarch; sufficient Racine castor oil to make it of the desired consistency. Add stearine if too soft. 2. Another receipt is two parts of beeswax, and one part bayberry wax. I have found powdered chalk useful to remove stickiness of this wax. C. W. SHELLY.

Niagara Falls, N. Y.

BLUE PRINTING FORMULA.

I have used the following recipe for blue prints with much satisfaction. The same formula may be applied for postal cards on which it is desired to print landscapes or similar views. Make a solution as follows: Water, 3 ounces; ammonia citrate of iron, 300 grains; oxalate of potash, 75 grains. Dry in the dark, print and then develop in the following: Water, 3 ounces; nitrate of silver, 15 grains; citrate of soda, 150 grams. Add ammonia to dissolve the precipitate, and acetic acid until slightly acid. Wash slightly and dry. I have found this to make a better blueprint in every detail than any other of the various known recipes.

Orange, Conn. ROBERT B. OTIS.

LUBRICANT FOR PIPE SCREW THREADS.

The best "dope," so called in shop parlance, that I have ever seen used for making pipe connections, is composed of 1 pint of "black strap" machine oil, ½ pint graphite, ¼ pint of white lead, and a teaspoonful of flour emery. These proportions are not exact, but they are substantially what are used. The object of the flour emery is to polish the threads as they are being screwed together. The graphite, white lead and oil make a fine lubricating mixture, which has enough consistency to stop incipient leaks. I have seen many large pipe radiators made up using this mixture, and they never leaked a drop when the steam was turned on.

Altay, N. Y. M. E. CANEK.

CHEMICALS FOR BLUEPRINTS.

To make blue-print paper use citrate of iron and ammonia, 1⅞ ounces dissolved in 8 ounces of water, and red prussiate of potash, 1¼ ounces dissolved also in 8 ounces of water. Keep in separate bottles until wanted for use. When wanted for use, measure equal quantities from each of the above bottles. Shake so as to mix it well. It is then ready for putting on the paper. When the two are poured together, the mixture must be kept away from white light and should be applied in a room illuminated with a ruby light only. The paper must be dried in this room and kept in the dark until used. One ounce of mixed chemical will cover about 4 square feet of paper. DAVID MELVILLE.

Detroit, Mich.

PAINT FOR FITTING AND SCRAPING.

To make a paint for fitting and scraping get five or ten cents worth of scarlet vermilion (powder) at any store where paint is sold. Melt a tablespoonful of lard and mix into the dry paint until like thick cream, and when cold is just right. The vermilion is very fine and has no grit in it so that the least touch of the mixture shows.

This is better than the tube paint generally used, as being mixed with animal oil, it will stand exposure to the air for a year or more without drying; but the tube paint is mixed with vegetable oil and will soon harden on exposure to the air. Any colored paint powder can be used, which is preferred. To test for grit take some between the thumb and forefinger.

F. W. B.

* * *

MARKING PAINT.

In shops making a business of repairing machinery, it is generally necessary to mark the parts of machines in some way so that they may be properly reassembled. This is especially true in railway shops, where the marking is necessary more for the purpose of distinguishing the parts of different engines. The best way to mark such parts, of course, is to stamp them with steel dies; but this is not always practicable, and, in the absence of such means of marking, it is customary to use a marking paint made of white lead mixed with turpentine to a thin consistency. Such paint dries quickly and when dry is not easily removed. It has the advantage of showing up fairly well on greasy surfaces; but it is better that the surfaces to be marked should be well cleaned with kerosene oil before marking. F. EMERSON.

Newark, N. J.

* * *

In this age, when iron and steel are so plentiful and such a necessary part of our civilization, it is difficult to realize that only a few hundred years ago iron was so scarce that it was ranked with the precious metals. Even as late as the time of Edward III. of England, iron was so rare that the pots, spits and frying pans of the royal kitchen were classed among the king's jewels!

* * *

An interesting improvement in the process of obtaining a high vacuum is reported to have been developed in England by Dewar. The method commonly employed for obtaining the high vacuum required in incandescent lamps and similar apparatus is the quick-silver process, *i. e.*, Sprengel's air-pump. This method, while fairly satisfactory, is slow in operation and requires a great volume of apparatus where a large number of lamps are being manufactured. The Dewar process is very simple and quick in operation. It depends upon the absorption power of charcoal when cooled. It appears that as charcoal is cooled down to the temperature of liquid air the absorption of air takes place so energetically that, if the charcoal is contained in a closed vessel, the air in the latter is soon exhausted. Charcoal made from cocoanut shells is preferably used and this is contained in a tube attached to the vessel to be exhausted. The tube is immersed in liquid air and in a few minutes the air in the tube and vessel has been absorbed. The method also possesses the advantage that the moisture is condensed in the tube.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

1.—R. B. R. Kindly give me an explanation of the process of coating gray iron castings with tin, or a composition, such as is used in the covering of castings employed in the manufacture of meat choppers and similar machines.

2.—G. W. E. Kindly explain through your columns how to magnetize U bends of steel having positive and negative poles at the ends of the U. The steel is 5/16 inch by 2 inches, and the arms of the U are 6 inches long bent the flat way. I desire to use magnets for the fields of an electro-magnetic generator, or "Magneto." I have tried to magnetize them on the fields of a 500-volt Westinghouse generator (old style); and I also have tried winding No. 21 B. & S. gage magnet wire on each end of the U, having one pound in each coil and running a current through them from a direct-current 110-volt machine with 6-16 candle power. Neither method, however, has given satisfactory results, though the steel was as hard as heating to a cherry-red and dipping would make it. Is there any special brand of steel better to use than the ordinary spring steel?

Answered by Wm. Baxter, Jr.

A. The best way to magnetize permanent magnets is with wire coils, in precisely the way you tried. You did not meet with success principally because you did not pass enough current through the coils. The quality of the steel may also have had something to do with it. The best steel for permanent magnets is the old-time tool steel. Make a keeper of soft iron, about 1 inch square, and fit it well to the ends of the magnet; then put the wire coils in place, connect them in series, and while the keeper is against the ends, connect the coils in a 110-volt circuit. Let the current pass for a few seconds, or until the coils begin to warm up, disconnect, and the magnet will be well magnetized. The magnet should be hardened in salt water with ice in it, and after being polished should be drawn until the faintest shade of straw color appears. After this magnetize.

* * *

DANGER OF COCKS IN STEAM GAGE PIPES.

It develops that the disastrous explosion which occurred on the gunboat *Bennington*, July 21st, was indirectly caused by a cock being closed between one of the boilers and its steam gage. It appears that the fireman was instructed to shut off the air cock which is provided for discharging the free air in a boiler when firing up, but by mistake he closed the steam gage valve. Two boilers, A and B, were being fired up, and although a pressure of 135 pounds was registered on the steam gage of boiler A, that of boiler B failed to register more than 5 pounds pressure. Notwithstanding this the fireman kept working the fires and shoveling in coal until the disaster occurred. It also developed in the naval inquiry that the safety valves were not regularly lifted from their seats, and the sentinel valves had not been overhauled for over a year. The hand gear for lifting the safety-valves was not in working order, and there is no record nor direct evidence that the safety valves had been tested.

While there is undoubtedly good evidence of gross neglect on the part of officers in charge, there is also evidence of a serious mistake in boiler design in putting a cock in the pipe leading to the steam gage. While we are not conversant with all the conditions that surround a boiler in naval service, we know that with other steam boilers this practice has been found very unsafe and is almost universally condemned. Of course it is very convenient to have a cock so located, as the steam gage can then be removed at any time and tested; but such construction is so fraught with the possibility of disaster that we believe that it should be strictly prohibited. It is better, a thousand times, that steam be blown off a boiler so that the steam gage may be tested or changed, than to run the risk of having a disaster occur because of a simple convenience. Of course, a steam gage is not a direct safety appliance except as it appeals to the sense of the fireman; but safety valves sometimes stick even when attended to with great regularity. In boiler practice we should neglect no means making for security, and if it is proven that a cock in a steam gage is dangerous, by all means abolish it.

A case illustrating the danger of a cock in a steam gage pipe occurred in the writer's experience: A locomotive had been overhauled, during which work the safety-valves had been ground and the springs reset by guess, as was the custom. The boiler was being fired up in the yard but the fireman, who was not over-well blessed with common sense, finally complained that he was not able to get the necessary pressure. The best he could get was about 35 pounds. The man who was responsible for setting the safety-valves happened to go out to examine some other matters when he discovered that the cock in the steam gage pipe was closed. Upon opening it the pointer at once went around the circumference of a 250-pound gage and struck the stop pin. Needless to say the pressure was quickly reduced by relieving the springs. There is little doubt that had it not happened that this timely discovery was made a disastrous explosion would have occurred.

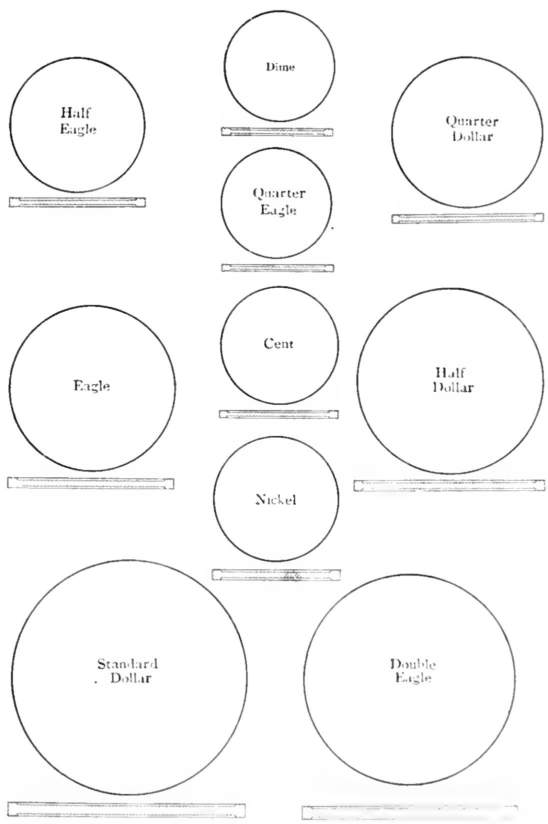
* * *

PRESSURE REQUIRED FOR STAMPING UNITED STATES COINS.

The following table and illustration are from a pamphlet issued by the E. W. Bliss Co., Brooklyn, N. Y., describing their line of minting machinery. The pressures quoted in the table are from tests made at the United States Mint, Philadelphia.

U. S. Coin.	Metal.	Tons Pressure.	U. S. Coin.	Metal.	Tons Pressure.
Double Eagle	Gold	155	Half-dollar	Silver	98
Eagle	Gold	110	Quarter-dollar	Silver	60
Half eagle	Gold	60	Dime	Silver	25
Quarter-eagle	Gold	35	5 cent nickle	Nickel	60
Standard dollar	Silver	160	1 cent	Copper	40

The above pressures are correct within about 5 per cent.



These Outlines show the Diameter and Thickness of the U. S. Coins mentioned in above List.

* * *

What is probably the most extensive dust collecting system on this continent is now in successful operation in the planing mill and cabinet shop of the Canadian Pacific Railway at its Angus Shops in Montreal.

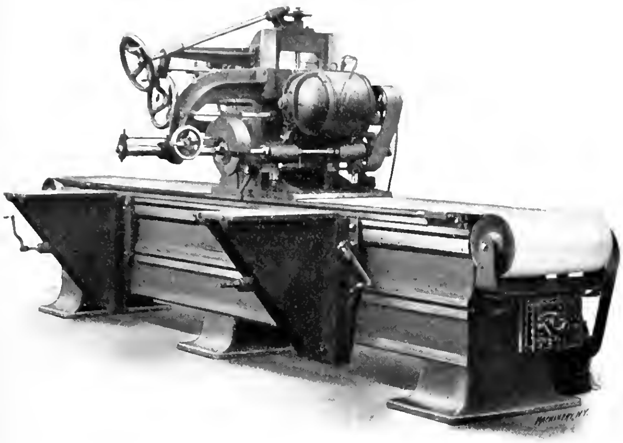
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

TRAVERSE GRINDER.

This machine has been designed especially for grinding manganese cast steel centres of railroad frogs and crossings, locomotive cross head guides, finishing butt ends of connecting rods, etc., and is, also, adaptable for grinding the ways between the V's on lathe beds, and for other grinding purposes.

The bed is cast in box form and is braced internally by means of cross girts and can be furnished in varying lengths, the illustration showing one 15 feet long, which permits a 12 foot longitudinal travel of the wheel. The saddle which carries the wheel is traversed by a 2 H. P. motor through a rack



Traverse Grinder.

and pinion at a speed of 15 feet per minute, and is automatically reversed at each end of the stroke which may be adjusted to any length up to the limit of the machine.

The grinding wheel, driven by a 5 H. P. motor at a speed of 1,500 R. P. M., has a horizontal movement in the direction of its axis of 15 inches, and a vertical movement of 11½ inches, these movements being operated, one by the hand wheel attached to the bracket supporting the grinding wheel shaft, and the other by the large hand wheel whose shaft is set at an angle. The third hand wheel is for moving the saddle by hand when desired. The motor is adjustable on the saddle, for the purpose of tightening the belt driving the grinding wheel shaft.

The tables are horizontally adjustable along the bed, by means of a screw, operated by the socket wrenches attached to them. A pump and system of piping is provided for supplying water to the grinding wheel, and canvas curtains are used to protect the sliding ways on the top of the bed from flying grit.

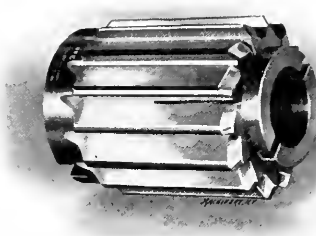
All controls are located in the saddle; a lever, not visible in the cut, being provided for reversing the saddle by hand when necessary. This grinder is built by the Cincinnati Shaper Co., Cincinnati, O.

NEWTON SLAB MILLING MACHINE.

The accompanying half-tone shows a plain slab milling machine recently furnished to one of the large electric companies by the Newton Machine Tool Works, Philadelphia, Pa. The spindle of the machine is 5 inches in diameter, and will swing a cutter up to 12 inches in diameter; the spindle has an adjustment on rail of 6 inches for convenience in setting cutters. It is driven by a 7½ H. P. motor through gearing by hardened steel worm and phosphor bronze worm wheel of steep pitch. The cross rail is counterweighted, and is of new design with inclined face. With this design of rail, the thrust of cut is transferred directly to the uprights, which are made of extra heavy proportions; it also largely overcomes the vibration and tendency to rise when running from a wide to a narrow section, so prevalent in the straight type of cross rail. The carriage is 23 inches wide with feed for a cut 8 feet long, is operated by spiral pinion and rack, has variable feed through friction disks, and power quick traverse in either direction by reversing motor. The table itself has flat bearings on the bed, and is of the outside gibbed design.

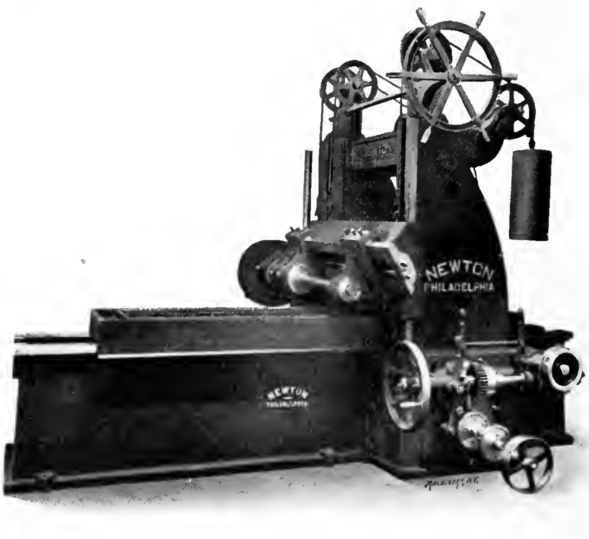
EXPANDING CORE DRILL.

The expanding shell drill shown in the accompanying half-tone is made by the Three Rivers Tool Co., Three Rivers, Mich. This tool is made in various sizes, and is designed to be used on a standard shell reamer arbor for finishing cored



Expanding Core Drill.

holes. The 3-inch size, which is shown in the half-tone, will take a cut ¼ inch deep on a side. As the reamer wears, it may be expanded by screwing in the taper shell, shown at the right-hand end, and then grinding down to size again. When made in solid form for use in the chucking machine, a solid taper plug is used instead of the taper shell for expanding the reamer. The solid reamer or drill may be obtained in smaller sizes than 1 15-16 inches, which is the limit for the shell form.

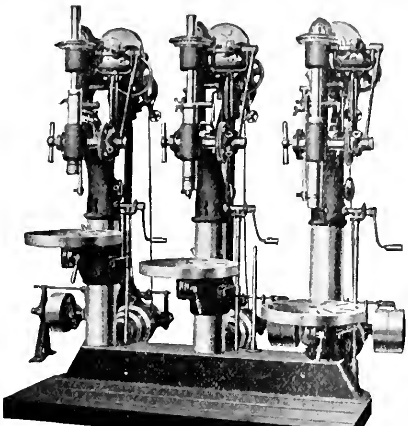


Newton Slab Milling Machine.

TWENTY-THREE INCH MANUFACTURERS' GANG DRILL

The B. F. Barnes Co., Rockford, Ill., has added a 23-inch size to the line of manufacturers' drills of which they make a specialty. This size differs from the 14 and 20-inch in that it is regularly built with independent columns and tables, although it will also be furnished with a heavy supporting pillar and single table, after the style of the smaller sizes,

if the customer so desires. The feature of these machines is the fact that for manufacturing work a large number of them may be run by one operator. After the work has been placed in position on the table, the drill is started by the touch of a lever, the spindle advances rapidly until the drill reaches the work, and then the slow feed is thrown in. An automatic

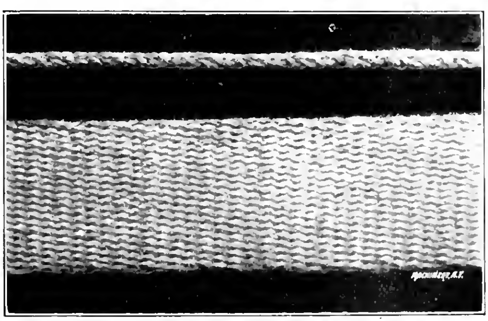


Barnes Manufacturers' Drill.

stop throws out this feed when the cut is completed, and returns the spindle at once to its first position. No attention is required on the part of the operator other than that necessary to keep the machine supplied with work. The 23-inch size, which is here illustrated, is built for considerably heavier work than the other machines of this line. It is strong enough to drive a 1½-inch twist drill in solid material, and will bore out considerably larger holes in cored work. Each spindle has independent feed and independent speed. The individual column style provides for independent adjustable tables for varying heights of work. The tables are regularly furnished in round style, but when oil pump attachment is required, square tables with oil channels will be provided, the only extra charge made being for the oil pump equipment.

A HIGH-SPEED COTTON BELT.

The botton belt of which a section is shown in the half-tone below is designed particularly for use at high speeds, to do away with the trouble experienced in running leather belts over small pulleys revolving at high velocity. It is woven

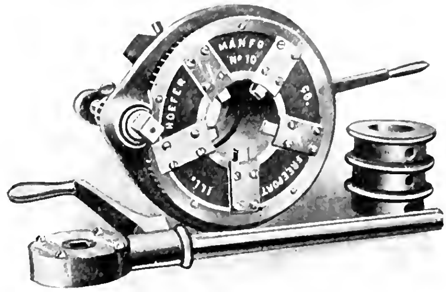


A High-epeed Cotton Belt.

endlessly, without lap, or joint, and its makers, the Creamery Belting & Supply Co., Hinsdale, Ill., claim that it will greatly out-last and out-wear any leather belt in the service for which it is designed.

POWER PIPE THREADING MACHINE.

The pipe threading machine shown in the accompanying cut is made by the Hoefer Manufacturing Co., Freeport, Ill. The machine is capable of threading pipe of any material to a standard taper thread, as the dies slightly withdraw as they feed forward, thus increasing the diameter of the thread. The dies feed forward automatically, so the operator does not have to force them forward on to the work, the gear in which the dies move being drawn in toward the work by a threaded sleeve of the same lead as that of the dies. The thread is cleanly cut to the proper taper, and it makes a well fitted joint, leaving the pipe strong where the thread terminates. A valuable feature of the machine is the provision made for quickly adjusting the thread to a size slightly above or below the standard. Another point is that it requires but one set of chasers (five in a set) for each size of machine to cut the thread



Power Pipe Threading Machine.

on any pipe within its range. Since the dies are not removed from the machine, they are not easily lost. When they become dull they may be readily sharpened by simply grinding the face, and as they are all numbered in their proper order, any number may be duplicated. The revolving parts are so protected that they will not clog with dirt or chips.

WHITNEY CHAIN REPAIR TOOL.

This tool, which is shown in Fig. 1, has been gotten out by the Whitney Manufacturing Co., of Hartford, Conn., to facilitate the repair of their well-known "Whitney" automobile chains. Their detachable roller chain has been adopted by

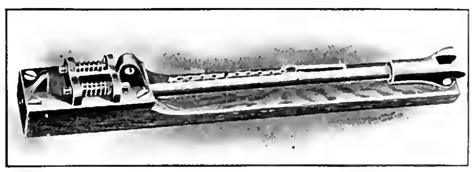


Fig. 1. Whitney Chain Repair Tool

many of the leading automobile manufacturers. This new device is intended to make the chain more popular from the users' stand point. Every "Whitney" Detachable Chain contains one connecting link, which is distinguished from the

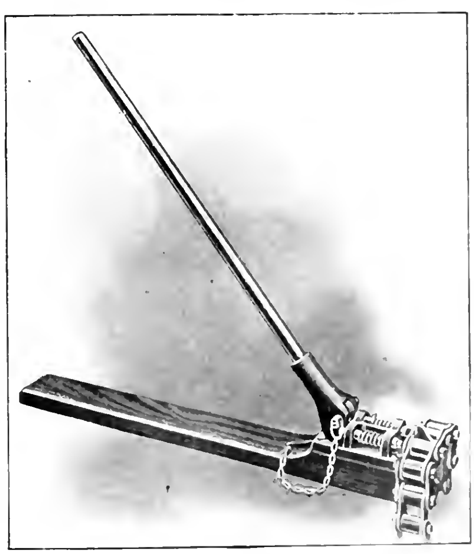
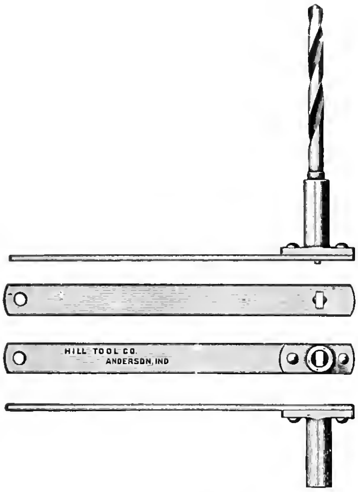


Fig. 2. The Repair Tool at Work

others by notches in the top surface. This link fits loosely on the rivets and may be removed by hand with ease. All of the other detachable links, however, are purposely forced tightly on to the rivets, and certain users have had some difficulty in removing them on this account. As the rivets are made very hard, the ends will sometimes crack through the cotter pin hole when a user undertakes to detach the chain by means of a hammer or wrench. The new device shown in action in Fig. 2 eliminates all such difficulties, the links being removed with the greatest ease, and with no danger of damaging any of the parts.



A New Drill Holder.

The device will be placed on the market soon after October 1st, and it will be made for all sizes of "Whitney" Detachable Roller Chains.

THE HILL STANDARD DRILL HOLDER.

The Hill Standard Manufacturing Co., of Anderson, Ind., have placed on the market the improved drill holder shown in the accompanying half tone. This holder is made in such a way as to combine lightness and strength. The handle portion of the tool is made of steel, hardened at the end which is riveted to the body of the holder. Through the handle at this point is cut a slot into which the tang of the drill projects, thus preventing it from turning. The fact that the metal around this opening is hardened, lessens the possibility of its being distorted by the torque of the drill. To insert the drill it is simply placed in the holder and given a tap, in which position the tang extends beyond the back face. To remove, the tang of the drill is given a slight blow, thus loosening the drill at once and obviating the use of drift. Should occasion require the use of a drill with the tang twisted off, the countersink on the back side of the holder forms a seat for the lathe center.

TWO SPECIAL GRINDERS.

The Safety Emery Wheel Co., Springfield, Ohio, have recently constructed two special grinders for their customers. In Fig. 1 is shown a surface grinder of the planer type, which was built for the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railway, to grind their guides and other flat work. The head which carries the wheel of this machine has an automatic reciprocating motion on the cross rails, as well as the usual back and forth movement of the table. This movement may be changed to take place at either the cross rail or the table by the movement of a hand lever. The back and forth movement of the wheelhead is obtained in a simple manner, from a single pulley, which revolves a shaft on which is mounted a set of differential gears which are alternately connected by a clutch to the screw, from which the head takes its motion. The reversing movement is effected automatically, the lateral movement of the wheel head combined with that of the platen tending to keep the base of the wheel true, thus insuring perfect work. All parts of the machine can be operated from the front side. The table has a lip three inches high above the working part of the platen, so that the under side of the work can be buried in water, if desired to keep the work cool. A centrifugal pump furnishes a large supply of water to the wheel to keep the work cool and remove loose

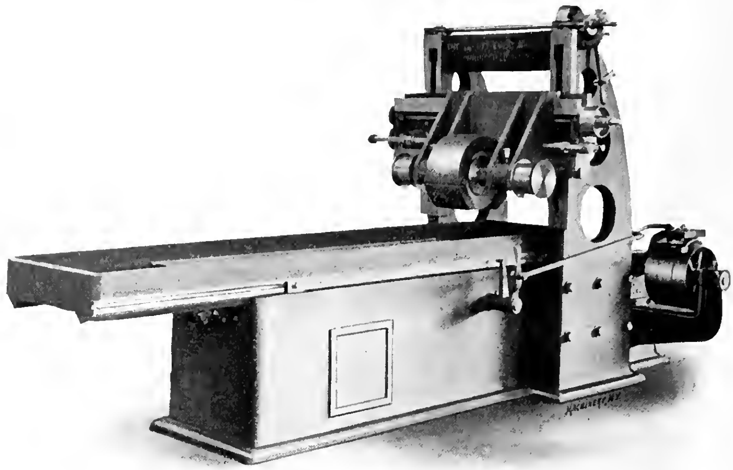


Fig. 1. Planer Type Surface Grinder.

emery. The base of the machine has a solid bottom, thus acting as a reservoir to hold the water and retain the dirt, which may be easily removed therefrom at any time. The machine weighs about 10,000 pounds, the table has a working surface of 18 inches by 72 inches, and will take in work 20 inches high. A longer table will be furnished if desired.

The machine shown in Fig. 2 is a grinder made for the National Tube Co. for finishing the larger sizes of ball dies which are used in making welded tubing. Some of these dies

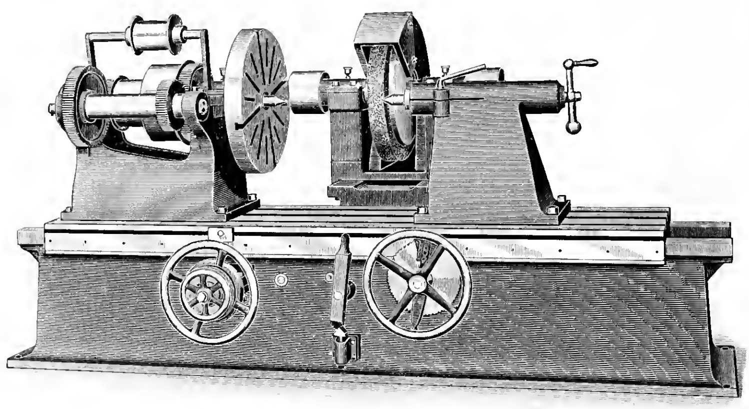


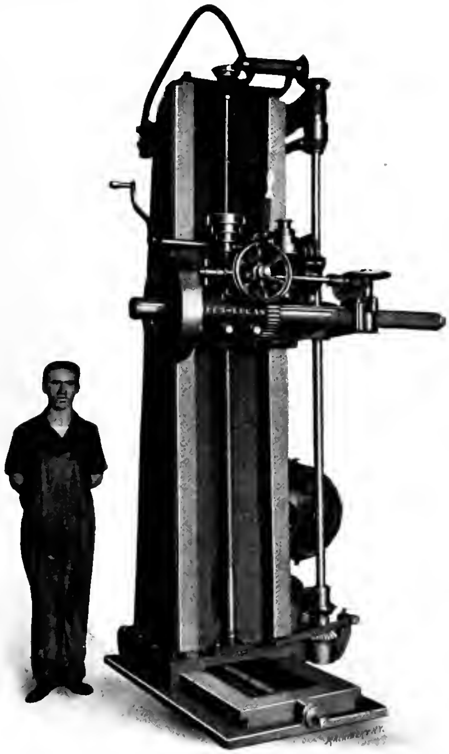
Fig. 2. Special Ball Die Grinder.

weigh as much as 300 pounds each. The machine will take in work 40 inches between centers, 36 inches in diameter. The reciprocating movement for the table is obtained from separate pulleys in the counter shaft. The emery wheel, which feeds automatically toward the work at every stroke of the table, is carried by a carriage at the rear of the machine. The weight of this machine is about 10,000 pounds.

PORTABLE BORING, MILLING AND DRILLING MACHINE.

This machine is intended primarily for use in connection with the floor plate system of building heavy electrical machinery. The example shown in the cut has a vertical travel for saddle of 72 inches, a horizontal movement on the base of

24 inches, and a spindle feed of 24 inches. All these feeds are automatic in either direction, thus making the tool suitable for milling and counterboring as well as for boring and drilling. It is sufficiently heavy and rigid to allow the use of an 18-inch high speed steel inserted tooth cutter head, and the range of speeds and feeds is designed to cover all cases from cutters of this size down to small drills. The spindle is made of hammered crucible steel, 4 inches in diameter, and feeds through

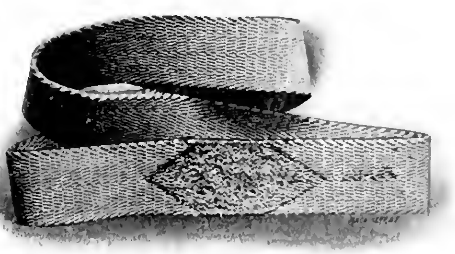


Portable Boring, Drilling and Milling Machine.

a gun metal sleeve. It has a No. 6 Morse taper hole in the end, also a pin hole for retaining the bars and holding tools in place. The machine shown in the cut is driven by a 3 to 1 variable speed Crocker-Wheeler motor. The gearing is made of hammered crucible steel cut from the solid, and bearings are all lined with bronze. The Espen-Lucas Machine Works, Philadelphia, Pa., are the builders.

AN ENDLESS COTTON BELT.

Messrs. L. H. Gilmer & Co., 3952 Market St., Philadelphia, Pa., make a cotton belt for severe service, which is shown in the accompanying cut. The salient feature of this belt is the



The Gilmer Endless Belt.

splice which may be noticed by its diamond shape; it is formed by interweaving strands of the two ends of the webbing. This webbing is specially made for L. H. Gilmer & Co., of high-grade material, and is woven in such a manner that it may be worn nearly half-way through before the separate strands begin to pull apart. It costs less than a leather belt, is more pliable, and is unaffected by oil.

A patent controlled by B. F. Sturtevant Co., of Boston, Mass., has just been issued for a special type of exhaust hood for grinding and polishing wheels. Its special feature consists of a receptacle to catch the particles of solid matter passing from the wheel. The suction being controlled so that it is not quite sufficient to draw them away, these particles fall to the bottom and are there collected, while the practically free air passes through a collector where the last vestige of dust is removed. The receptacle can be readily emptied when it becomes filled, and its use avoids excessive wear on the exhaust fan, piping and collector.

The hood is so designed with hinges and clips that the wheel may be readily removed or adjusted to fit the wheel as it wears to a smaller diameter. The outlet is connected to the exhaust fan, and a shield, a swivel plate and an extension slide may be adjusted so as to more fully enclose the wheel and prevent the discharge or particles into the room.

* * *

CAUTION!

As we go to press our attention is called to the fact that the receipt entitled "To Harden Cast Iron," published under "Machine Shop Receipts and Formulas" in the April number of MACHINERY, is of a dangerous character if improperly compounded. Among the ingredients is sulphuric acid and the poison cyanide of potash. When cyanide of potash and sulphuric acid combine, hydrocyanic acid gas is generated, which is a deadly poison to inhale. Great care should, therefore, be taken not to add the sulphuric acid to the cyanide of potash until the latter has been placed in the ten gallons of water called for by the receipt, so as to dilute the solution and render the generation of the gas less rapid. Under no circumstances should this rule be deviated from.

* * *

THE WARRANT MACHINISTS IN THE NAVY.*

A contributor who signs himself "W. M." gives an explanation of the position occupied by warrant machinists in the navy, the requirements for the position, duties, responsibilities, etc. The advent of the warrant machinist came with the navy reorganization bill of 1899 and there are now 180 such machinists, which, however, is only about half the number actually required to perform the duties devolving upon them. Owing to this scarcity, none have been available for gunboats or destroyers. The following extracts from the navy regulations give an idea of the qualifications:

"Vacancies in the list of warrant machinists shall be filled by competitive examination before a board ordered by the Secretary of the Navy, and open to all machinists in the navy, and to other machinists of good character, not above thirty years of age, authorized by the Secretary of the Navy to appear before the board.

"With applications from machinists in the navy there must be statements of opinion of the commanding officer and engineer officer under whom the applicant is serving. These opinions will be limited to the question of whether the applicant is regarded as qualified for the position of warrant machinist and worthy of such advancement.

"Applicants from civil life must furnish testimonials of good moral character and correct habits, and certificates showing experience in machine shop, and in the engine room of a steamer. . . . No applicant from civil life will be examined who is not a machinist by trade, and has not had the care and management of the steam machinery of a sea-going vessel in regular service."

These examinations, which are held annually in September, embrace a general knowledge of the engineering business, such as is gained by all practical engineers through their trade as a machinist, their earlier experience at sea, and probably through the use of a considerable quantity of "midnight oil" applied as a lubricant to the mental wearing surfaces.

* From Marine Engineering, September, 1905.

Sea Duties.

Warrant machinists act as assistants to the engineer officers of the ship in all that relates to the care and maintenance of the machinery. Machinists are assigned to the different departments of the vessel according to their ranks; senior in rank being in the starboard engine room, second in the port engine room, third in the fire rooms, and the junior has duties in connection with the auxiliary machinery. The warrant machinist must also do watch duty, similar to that performed by the assistant engineer of the mercantile marine. They have to stand regular watches, not more than four hours each. The engine room watch on war ships consists of one warrant machinist, one machinist in charge of each engine, two oilers in each engine room, one storekeeper, and one coal passer, detailed as messenger. In port the warrant machinist performs "day's duty" which begins at 8 A. M. and continues for twenty-four hours, though it is permissible to turn in from 9 P. M. to 5 A. M., but subject to call at any time. If there are four efficient warrant machinists, the practical engineering duties can be well performed without taxing their endurance. The senior engineer officer to whom warrant machinists are responsible is usually a lieutenant-commander or a lieutenant, generally a considerate officer. As a general thing, the warrant machinists are allowed the freedom of their own ideas in pursuing mechanical methods, which their experience indicates to be the most successful.

Shore Duty.

It is an unwritten rule in the navy, in time of peace, that three years' sea duty constitutes a "cruise," after which officers are assigned to shore duty for such period as the exigencies of the service will permit. This period is usually about two years, in the case of most warrant officers, which is an agreeable relaxation from life on board ship. On shore, warrant machinists are assigned as assistants to the engineering officers at navy yards, where their duties consist of detail work in connection with vessels building or under repair. They are also assigned as assistants to the naval inspectors at private shipyards where war vessels are under construction; and they act as assistants to the inspectors of material at various places where naval material is manufactured.

Unfortunately, however, owing to the limited number of warrant machinists in proportion to the demand for their services at sea, they have not enjoyed as much shore duty as other warrant officers. It is hoped steps will soon be taken to remedy this defect through proper legislation. At present the increase is limited by law to twenty appointments yearly. This fact, combined with the knowledge that warrant machinists obtain comparatively little shore duty, tends greatly to retard the healthy growth of the corps.

Promotion.

1. Boatswains, gunners, and warrant machinists having four years' service as warrant officers, and being under thirty-five years of age, are eligible for promotion to ensign, and are then in line of promotion to highest rank.

2. All warrant officers (except warrant machinists, for whom it is hoped the law will provide at an early date) are, after six years' service as warrant officers, eligible for commission as "chief" in their respective grades, "to rank with, but after, ensign."

The examination for ensign embraces navigation, seamanship, ordnance, and steam engineering, and is not beyond the attainment of one having a good common-school education who becomes a warrant officer under thirty years of age. Of ten warrant officers who successfully passed this examination in 1904, three were machinists.

Promotion to "chief" grade is made upon physical and moral fitness; a satisfactory showing in the efficiency reports during the previous six years; and upon passing an examination in a few subjects in which much care, judgment, and responsibility are involved. This promotion carries the distinction of a commission, and the pay of an ensign, but "does not include additional right to quarters, nor to command." Its main advantage is the increase of pay after reaching the maximum, which is shown as follows:

Highest sea pay of chief grade	$1,960
Highest sea pay of warrant officer, with ration	1,908
Increase	$52
Highest shore pay of chief grade, with allowance	$2,248
Highest shore pay of warrant officer, with allowance	1,888
Increase	$360

Pay.

The sea pay of warrant machinists ranges from $1,200 to $1,800 per year, depending at date of appointment upon whether appointed from civil life, or from the navy, with previous service. Those appointed from the navy advance as follows: after three years' service, $1,300; six years, $1,400; nine years' service, $1,600; twelve years' service, $1,800; or maximum pay of warrant officers. Those appointed from civil life are credited by law "at date of appointment, for computing their pay, with five years' service." Thus it will be seen that a warrant machinist appointed from civil life enters on $1,300 per year, and one year later is advanced to $1,400; four years later to $1,600; and seven years later to $1,800. To the yearly sea pay at all times may be added $108 extra allowed for rations. Shore pay is about 10 per cent less than sea pay, but the "allowance" is greater on shore than "rations" at sea.

When "incapacitated for the further performance of duty at sea," officers are retired on three-fourths of their sea pay; and at the age of sixty-two, all officers retire on three-fourths pay.

* * *

The usual method of detecting leaks in the vacuum system ot compound engines is to examine the joints by means of a lighted candle. The points where air is drawn into the system will be shown by the flame of the candle drawing inwards. This test, however, is not of the greatest reliability, as it is not delicate enough to show such flaws as a spongy casting which might admit a large volume of air in total, but which is not a localized fault sufficiently great to deflect the candle flame appreciably. One of the "wrinkles" contributed to a paper presented at the June convention of the National Electric Light Association, suggests a method by which such leaks can be detected. It is turning the full steam pressure into the exhaust pipe, between the engine and the condenser. With a steam pressure of, say, 100 pounds, leaks that would defy the candle test are likely to be discovered. With the high vacuum required in steam turbine installations, it is important that the slightest leaks be stopped, and for this reason the scheme outlined by Mr. Hall, Fall River, Mass., is one worth using where leakage is suspected, but cannot be found by the ordinary method.

* * *

It appears from tests that have been made in the Sheffield district that the strength of a grindstone is considerably reduced when wet, as compared with a dry condition. The wetting not only reduces the tensile strength of the stone, but the added weight also, of course, makes the centrifugal stress greater for the same peripheral speed. This reduction of strength as between dry and wet, it appears, amounts to as much as 40 to 50 per cent. For example, a square-inch section stone when dry broke under a stress of 146 pounds, and when soaked in water over night, another piece of the same stone broke at only 80 pounds. In another case, the figures were 186 pounds and 116 pounds, the conditions being the same. Strange to say, there appears to be no settled standard as to safe speeds for grindstones. Some Sheffield grinders run their stones at 4,500 speed per minute, and others limit the speed to 2,500, but the number of breakages do not appear to be greatly influenced by the great difference in speed. It is very probable that a frequent cause of grindstone breakages is the presence of hidden flaws and cracks which increase in extent with use, and as the outside material is removed the strength of the stone is reduced to below the breaking limit.

* * *

Jack had no end of trouble with No. Naughty-naught on his homeward run, says *Railroad Men*. It had been almost impossible to keep up enough steam to make the trip; several parts had been running hot, and in fact everything went wrong. When he arrived at the yard considerably behind

MACHINERY.

November, 1905.

FANS.—2.

CHARLES L. HUBBARD.

Having taken up the centrifugal fan from a theoretical standpoint and noted its action under ideal conditions, we will now consider it when working under the requirements of actual practice, and show what corrections must be made to the various rules and formulas previously given.

General Proportions.

The general form of a fan wheel is shown in Fig. 11, which represents a double spider wheel with straight blades. Those over 4 feet in diameter usually have two spiders, while fans of large size are often provided with three or more. The number of blades or floats commonly varies from six to twelve, depending upon the size of fan. They are made both curved and straight; the former, it is claimed, run more quietly, but if curved too much will not work so well against a high pressure as the latter form. Fig. 12 represents a section through a fan wheel and shows the principal dimensions to be considered.

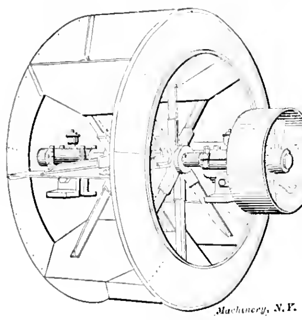


Fig. 11. Construction of Fan Wheel.

The following proportions are averages taken from fans of different sizes as made by several manufacturers for general ventilating and similar work and will be found to vary slightly from the proportions given by any one maker.

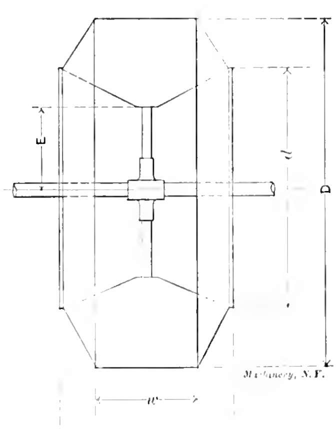


Fig. 12. Diagram of Fan Wheel.

The diameter of the inlet (d) usually varies from .66 to .7 of the diameter of the wheel (D), .68 has been used in the following tables as a fair average. The distance from the center to the heel of the blades (E) is generally made .25 of the diameter of the wheel.

The width W varies somewhat in fans designed for different purposes. In the makes examined it averaged from .50 to .54 of the diameter, and .52 has been used in the tables following. The width at the periphery should be, theoretically, such that the area of outlet around the entire wheel will be the same as the sum of the openings between the blades at the inlet, but in actual practice it is made somewhat greater, averaging from .7 to .8 of the width of the wheel. For convenience the relations between the different parts of the wheel may be expressed by the following equations:

$d = .68\,D$
$E = .25\,D$
$W = .52\,D$
$w = .8\,W$

in which

D = diameter of wheel,
d = diameter of inlet to wheel,
E = distance from center of fan to heel of blades,
W = width of fan at inlet,
w = width of fan at periphery.

These proportions, as already stated, do not represent those of any particular make, nor follow any fixed rule, but are general averages as found from the catalogue dimensions of several well-known manufacturers.

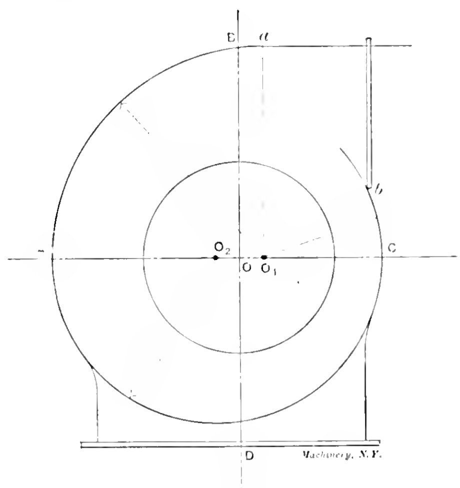


Fig. 13. Layout of Scroll Casing.

Fans are made both with double and single inlets; the former being called "blowers" and the latter "exhausters."

The dimensions of the casing or housing vary somewhat with different makers and can be obtained from their catalogues. The dimensions given in the following tables are taken from the catalogue of the B. F. Sturtevant Co. and will be found useful in the design of ventilating systems in approximating the space required. In case any particular make of fan is to be used, the exact dimensions should be obtained from the manufacturers, especially if the available space is limited.

The scroll of the casing is usually made up of the arcs of three circles of different radii, and the following method will be found useful in laying out a fan casing to scale. (See Fig. 13.)

First draw the center lines and lay off the distances OA, OB, OC and OD from the catalogue dimensions of the fan to be used. Then with a radius R, equal to OB, and a center at O_1 draw the arc Aa; with the same center and a radius R_1 equal to O_1C draw the arc bC; lay off $OO_2 = OO_1$ and with a radius R_2 equal to O_2A and a center at O draw the arc AC. The other bounding lines can then be drawn in from dimensions taken

from the catalogue table. The width of the casing is practically the width of the wheel with a small allowance for clearance.

Form of Orifice.

The form of the opening through which air passes when under pressure has a certain effect upon the quantity discharged, and makes it less than the theoretical amount which the size of opening and difference in pressures would indicate. This reduction is due to two causes. First, to a contraction of the stream within, or just beyond the opening, depending upon its form, and second, to a certain amount of friction which tends to reduce the velocity somewhat.

The ratio between the actual quantity of air discharged and the theoretical quantity is called the "coefficient of discharge" and may be taken as about .8 for the short outlet from a fan casing, and as .56 for the inlet. Example: The pressure within a fan casing is ½ ounce per square inch, and the area of the outlet is 4 square feet. What will be the actual discharge in cubic feet per minute?

From Table I. (October MACHINERY) the velocity corresponding to a pressure of ½ of an ounce is found to be 3,653.8 feet per minute, which gives a theoretical discharge of 3,653.8 × 4 = 14,615.2 cubic feet per minute. To find the actual quantity we must multiply this result by the coefficient of discharge, which gives us 14,615.2 × .8 = 11,692.16 cubic feet per minute.

The quantity of air discharged through any given opening, divided by the velocity of flow, is called the *effective area*. In the preceding example 11,692.16 ÷ 3,653.8 = 3.2 square feet, which is the *effective area* of the outlet, while 4 square feet is th actual area.

Sometimes the conditions of the problem are such that it is stated as follows:

The pressure within a fan casing is ½ ounce, and the outlet is 4 square feet, how much must the pressure be increased to make the actual discharge equivalent to the theoretical at the original pressure? It can be shown mathematically that the ratio of the theoretical pressure to the actual pressure required is $\frac{1}{K^2}$ in which K is the coefficient of discharge. Taking this as .8 for a fan outlet, the ratio becomes $\frac{1}{.64} = 1.56$.

In the above example the theoretical discharge is 3,653.8 × 4 = 14,615.2 cubic feet per minute, in which it is assumed that 4 square feet is the effective area of the outlet. In order to make the actual discharge equal the theoretical, using the same sized outlet, it will be necessary to increase the pressure by 1.56, which gives us ½ × 1.56 = .78 of an ounce.

TABLE V. DIMENSIONS OF FULL HOUSING FANS.

Size of Wheel.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
2½	18¾	20½	23½	21	25	24	28⅛	27	16¾	17⅛	17⅝	21	15	18¾	19¾
3	22¾	22	26	24	30	26¼	33¾	33	20¼	20⅜	21⅝	27½	18	22¾	22½
3½	25¾	24½	29½	27¼	34¼	28¾	39¼	37¾	22½	23⅜	24⅞	31⅞	21	25¾	27
4	28⅝	31	31	31	39	30½	41¼	43	22⅞	23½	29	34	24	29⅝	30¼
4½	31¼	34½	34½	34	44	34¼	41¼	49	24¾	25¾	34	38⅞	28	29½	34¼
5	33½	35½	35½	37	49	36⅛	47	55	27	28	39	42⅜	32	33½	38¼
5½	37¼	40½	40½	40½	53½	40½	51	60	29	30¼	42	47	36	37¼	44
6	42½	46	46	44	58	41½	55	65	33	34½	44	52¼	42	42½	51
7	48½	49	49	50	68	45½	64	77	36¼	38½	53	60½	48	48½	57
8	54½	57	63	57	77	49½	72	87	38	39¾	60	68½	48	48½	59
9	60¾	63	73	65	87	57½	80	98	41	42¾	68	77	54	54¾	65
10	72¾	66	84	72	96	68½	88	108	44⅜	47	72	85½	60	60¾	71

TABLE VI. DIMENSIONS OF THREE-QUARTER HOUSING FANS.

Size of Wheel.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
4	28⅝	29½	36	31	39	30½	15	43	22⅞	23½	29	34	24	24⅝	35
4½	31¼	32	40	34	44	34¼	18	49	24⅞	25¾	34	38⅞	28	29½	39
5	33½	34½	44	37	49	36⅛	20	55	26¾	27¾	39	42⅜	32	33½	43
5½	37¼	38¼	48¾	40½	53½	40½	20	60	29	30¼	42	47	36	37¼	47
6	42½	40¾	52	44	58	41½	24	65	33	34½	44	52¼	42	42½	51
7	48½	47	62	50	68	45½	26¼	77	36¼	38½	53	60½	48	48½	59
8	54½	52½	69	57	77	49½	32¼	87	38	39¾	60	68½	48	48½	67
9	60¾	60	78	65	87	57½	36	98	41	42¾	68	77	54	54¾	76
10	72¾	66	85	72	96	68½	40	108	44⅜	47	72	85½	60	60¾	84

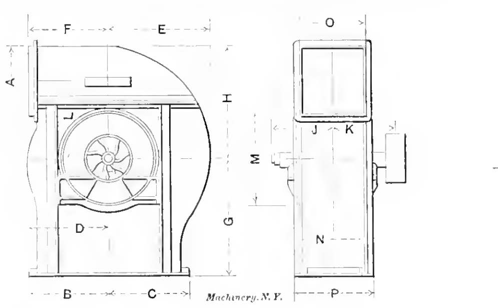


Diagram of Full Housing, use with Table V.

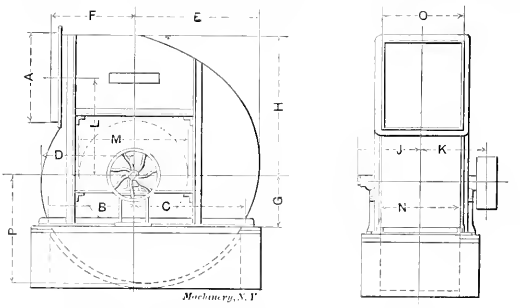


Diagram of Three-quarter Housing, use with Table VI.

Blast Area.

While the blast areas of fans of different diameters are slightly different for varying proportions, the formula $\frac{D\,w}{3}$ applied to standard fans will be found sufficiently accurate for ordinary use, in view of the approximations which must be made later in the assumption of pressures to be operated against, due to the friction of the air in ducts and flues.

Asuming $w = .8\,W$, and substituting for W its equivalent, $.52\,D$, we have for the blast area $A = D \times .8 \times .52\,D \times .33 = .14\,D^2$.

Table VII. gives the blast areas for fans of different diameters, computed by the above method, which will be found to correspond very closely with those calculated by more complex methods for fans of approximately the same proportions.

TABLE VII.

Dia. of Fan in feet.	Blast Area, in sq. ft.
3	1.26
3½	1.72
4	2.24
4½	2.84
5	3.50
6	5.04
7	6.86
8	8.96
9	11.34
10	14.00

Actual Capacity.

In the examples given under *Theoretical Capacity*, it was assumed that the effective area of outlet was equal to the blast area, so that the velocity of outflow could be taken the same as the tip velocity. In actual practice the effective area of outlet is always made greater than the blast area and consequently the actual volume of air discharged is greater than the theoretical. On the other hand, the pressure drops below that due to the tip velocity and the velocity of flow through the outlet is correspondingly less.

The size of discharge outlet varies somewhat for different makes, but for a large number of fans examined it was found to average about 2.23 times the blast area as computed by the preceding method. Assuming a coefficient of discharge of .8, it gives as the effective area of discharge, .8 × 2.23 = 1.78 times the blast area.

A series of carefully conducted tests made some time ago upon an enclosed fan of practically the proportions taken, showed the pressure producing the flow of air through the outlet to be about .7 of that due to the peripheral velocity, when the effective area of outlet was made 1.78 times the blast area as computed above. Calculations based upon tests made by one of the leading manufacturers of fans of similar proportions give practically the same result.

We have seen that the velocity corresponding to any given pressure, or in other words, the peripheral velocity necessary to produce any desired pressure may be found by the formula:

$$v = 65.5 \sqrt{h}$$

for air at 50 degrees temperature, when the effective area of outlet is equal to or less than the blast area.

TABLE VIII.

Dia. of Fan.	¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¼ oz.	⅞ oz.	1 oz.	1¼ oz.
3	5 690	6,960	4,380	8,980	9,840	10,600	11,350	12,700
3½	7,750	9,490	10,950	12,250	13,400	14 500	15,500	17,300
4	10.350	12 650	14,600	16,350	17,900	19,300	20.650	23,100
4½	12,950	15.850	18,250	20,400	22,350	24,150	25,800	28,850
5	16,050	19.600	22,650	25,500	27,750	29,950	32,000	35,750
6	23,250	28,600	32,900	36,750	40,250	43 450	46,450	51,900
7	31,550	38,600	44.600	49,800	54,550	58,950	62,950	70,350
8	40 850	50.000	57,750	64,550	70,650	76.300	81,550	91,150
9	53,200	63,950	73 750	82,500	90,350	97,560	104 250	116,500
10	64,100	78,500	90,600	101,300	110,950	119,800	128,000	143,050

If increasing the effective outlet area to 1.78 times the blast area causes the pressure to drop to .7 that due to the peripheral velocity, we must, in order to again bring the pressure up to its original point, increase the velocity of the fan tips to a speed given by the equation

$$v = 65.5 \sqrt{\frac{h}{.7}}$$

Assuming an original pressure (h) of 1, it is found that the tip velocity must be increased by 1.2 in order to produce this result.

This may be made clearer by an illustration: A 6-foot fan running at a speed of 191 revolutions per minute produces a pressure of ½ oz. with a discharge outlet having an effective area equal to the blast area. If the effective discharge outlet is made 1.78 times the blast area, at what speed must the fan be run to maintain the same pressure; that is ½ ounce?

194 × 1.2 = 233 revolutions per minute.

Table VIII. gives the cubic feet of air discharged per minute by fans of different diameters when run at such speeds as will produce the pressures indicated at the head of each column. These results were obtained by assuming the effective area of discharge outlet equal to 1.78 times the blast area, and multiplying this area in square inches by the quantities for the corresponding pressures as given in Table III. (October MACHINERY.) The results are given to the nearest ten, for quantities less than 10,000, and to the nearest fifty for those above 10,000.

Table IX. gives the speeds of fans of different sizes necessary to maintain various pressures over effective discharge areas equal to 1.78 times the blast areas. These results are obtained by multiplying the speeds given in Table II. by 1.2.

TABLE IX.

Dia. of Fan.	¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¾ oz.	⅞ oz.	1 oz.	1¼ oz.
3	328	403	465	531	570	615	657	734
3½	282	345	398	446	488	526	562	630
4	247	302	349	390	427	460	493	550
4½	219	268	309	346	379	410	438	489
5	196	242	278	312	342	369	394	440
6	164	201	232	260	285	307	328	367
7	140	172	199	223	243	264	282	314
8	123	151	175	195	213	230	246	276
9	110	134	154	172	189	205	219	244
10	98	121	139	156	170	184	197	220

Horse-power Required.

The power required for moving a given quantity of air under different conditions is given in Table III. This, however, does not include that necessary for overcoming the friction of the fan or the passage of the air through it.

The efficiency of a fan varies with the speed, the size of outlet, and the pressure against which it is working. Under favorable conditions, properly proportioned fans should have an efficiency of about 40 per cent., although they often fall considerably below this. The horse-power given in Table X. for different sized fans is obtained by multiplying the effective area of outlet, in square inches (blast area × 1.78) by the quantities given in column three of Table III., and dividing the result by .4 (the efficiency).

TABLE X.

Dia. of Fan.	H. P. Required for Different Pressures.							
	¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¾ oz.	⅞ oz.	1 oz.	1¼ oz.
3	1.0	1.9	2.8	3.8	5.0	6.4	7.9	10.8
3½	1.5	2.5	3.8	5.4	7.0	8.8	10.8	15.0
4	1.8	3.3	5.0	6.9	9.1	11.5	14.0	19.6
4½	2.3	4.0	6.3	8.8	11.5	14 5	17.8	24.8
5	2.8	5.0	7.8	10.3	14.3	17.9	21.9	30.5
6	3.9	7.3	11.1	15.3	20.4	25.8	35.1	44.0
7	5.3	10.0	15.3	21.3	27.9	35.1	42.3	60.0
8	7.0	13.0	20.0	28.0	36.7	46.4	56.8	81.0
9	8.8	16.1	25.0	34.8	45.6	57.5	70.4	98.5
10	11.0	20 3	31.1	43.5	57.1	72.0	88.0	122.9

* * *

It is easily demonstrated that motion must always be communicated to a body by pushing it; when drawn it is pushed by the hook or other coupling connecting it to the driving body. Reduced to the last analysis, motion is communicated by the impact of particles one against another. This means compression, and, in accordance with the ordinary conception of the term, a diminution of volume; but diminution of volume is not an invariable accompaniment of compression as a result of transmission of motion. An ingenious and simple method of illustrating this fact, and at the same time illustrating the physicists' conception of the effect of motion in the ether, is by the use of a rubber bag filled with shot. In a state of quiescence the shot lie closely together; but if motion is communicated to the shot by pressure directed against any portion of the bag its volume at once increases. This comes about for the simple reason that each individual shot requires more room when it is moving relative to its neighbors than when it is stationary.

A FLOOR PLATE BORING MILL AT THE CROCKER-WHEELER WORKS.

Perhaps the most radical change in the past ten years in the building of machinery is that which has taken place in the tools and methods employed in the construction of heavy electrical apparatus. The method by which this is mainly done nowadays is that known as the floor plate system. It consists, briefly, in fastening the work in its rough state to a suitably constructed floor plate, and performing as many as possible of the operations necessary to finish it without removing it from its fastenings. Various tools, such as drilling machines, slotters, milling machines, etc., are brought to the proper position by traveling cranes, fastened to the floor plate, and set at work; as many of these machines being employed on one casting as the size of the work and the convenience of the operations will allow. The machine which is described in the following paragraphs is a logical development of this system. Perhaps it would be nearer the truth to call it a revolving floor plate rather than a boring mill, as its functions seem to be rather those of the floor plate than of the machine which we commonly think of as the boring mill.

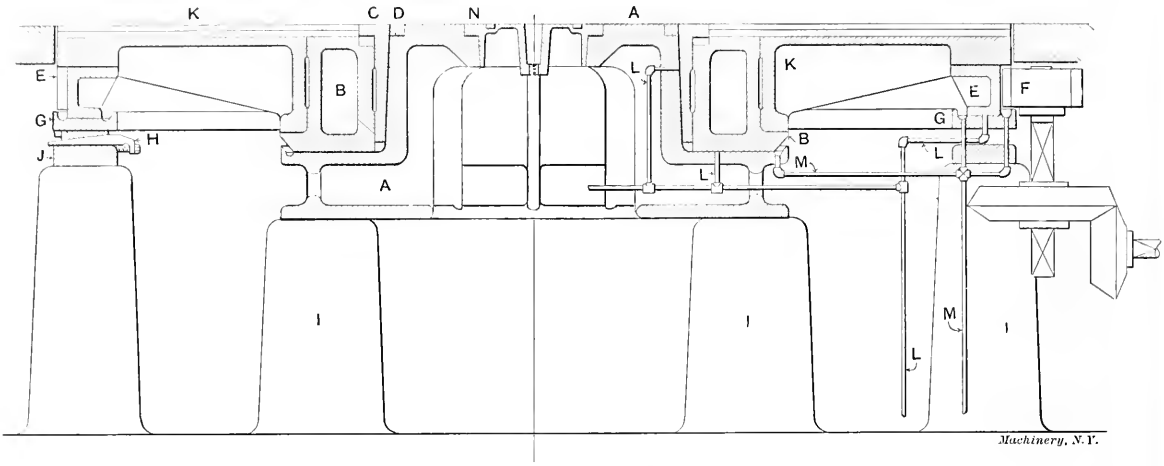


Fig. 1. Cross-section of Boring Mill Table.

The Crocker-Wheeler Co., Ampere, N. J., have recently gone into the business of making alternating current machinery, and are constructing generators of the largest capacity for this work. To keep pace with the demands for this product, they are building a new shop for handling the heavier part of the work. This building is about 60 feet wide and will eventually be about 500 feet long, although at present only enough of it is being completed to furnish quarters for the machine under discussion. The floor of the central bay will be made up of surface plates. These plates are built in sections 6 x 10 feet and mounted on concrete piers about 7 feet high, spaced far enough apart to allow easy access between them for the purpose of keeping the plates in alignment, and cleaning out the chips and dirt which fall down through the openings in the floor plate. The building is served by a 30-ton Niles traveling crane of 60 feet span.

Fig. 1 shows a vertical section through the center of the machine. It will be seen to consist essentially of a stationary center *A*, resting on cement piers, which acts as a support for a revolving annular platen or face plate. This is flush with the main floor plate of the building in which it is installed, and when not in use is simply a part of the floor of the building. The working surface of this revolving platen is composed of 16 T-slot segments. The platen was given this sectional form to facilitate repairs in case at any future time the T-slot edges should be broken, or the face plate surface itself cracked. The face plate is furnished with a hub *B* to which it is keyed, and which revolves in a suitable bearing on the base casting *A*. A tapered seat in the base casting locates this hub centrally, and adjustment for wear is maintained at this point by means of a sleeve *C* keyed to hub *B* whose outside surface is cylindrical, and whose inside surface is bored to the taper of the main casting. A packing ring *D* is furnished to make a tight joint between the revolving sleeve and the stationary casting, thus preventing dirt and chips from working down into the bearings. The lower surface of hub *B* seats on a horizontal annular bearing surface which is provided with a raised lip to retain the oil used for lubrication.

To a seat on the under side of the periphery of the face plate is bolted a circular cast-iron rack *E* made in eight sections. The teeth of this rack are one diametral pitch, and are cut from the solid. The pitch diameter is 18 feet, and the length of the teeth is 10 inches. A 16-tooth cast steel pinion *F* on a vertical shaft meshes with this circular rack and thus drives the table. The under side of the rack is made in the form of a flange to furnish a "safety bearing" for the table. This rests on a corresponding bearing surface on ring *G* which is furnished with lips on each side to retain the lubricating oil. This ring is supported by wedges *H* of which there are 32, evenly spaced around the circumference and supported by ring *J*, which seats on concrete piers *I*. In setting up the machine the bearing surfaces on the main casting *A* are first adjusted properly and then ring *G* is raised by means of wedges *H* until it just touches the under surface of the table gear *E*. It is not set up so far that it takes any of the weight of the table under normal conditions. If, however, the table

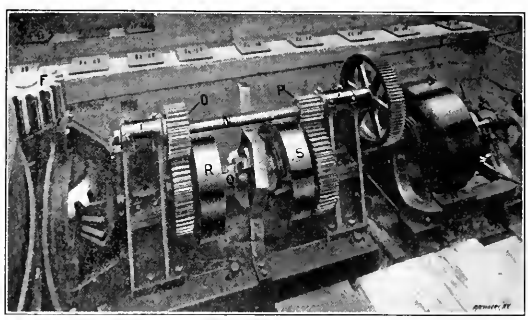


Fig. 3. Driving Mechanism.

be heavily loaded at any time, this bearing will come into play, and take care of any springing or deflection of the table. Fig. 2 is a reproduction of a photograph taken while the machine was being erected, and shows the table just being put into place. It gives a good idea of the different parts of the machine. In Fig. 3 is shown the table driving mechanism. Power is furnished by a 50-horse power standard shunt wound motor, and the speed changes are obtained partly through gearing and partly in the motor by use of the multiple voltage system. The connections in the controller give voltages of 40, 80, 120, 160, and 240 and field regulation provides for intermediate gradations. The motor is geared to the shaft seen at *N* in Fig. 3. On this shaft are mounted two pinions *O* and

P, which mesh with mating gears on the shaft *Q*. Either of these two gears may be connected by clutches *R* and *S* to shaft *Q*. This provides for a speed change ratio of about 2.16 to 1, and with the motor changes drives the table at a rate varying from .34 to 3.8 R. P. M. Shaft *Q* is connected to the vertical shaft which revolves the table through bevel gears at the extreme left hand end. A sheet metal roof covers this driving mechanism to protect it from chips and dirt which fall down through the openings in the floor plate above.

The bearings are lubricated by a forced oiling system, of which supply pipes *L L* and drain pipes *M M* may be seen in Fig. 1. In the vertical portion of the center bearing for instance, a supply pipe is tapped into the bearing at four equidistant points around the circle. Each pipe leads out into a vertical groove extending the height of the bearing. On the inner surface of sleeve *C* there is cut an undulating oil groove. As this sleeve revolves on the bearing, oil from the vertical in the main casting is introduced to this groove in the sleeve at every point along its length. These grooves are thus kept full of oil, which is wiped over every part of the bearing surface in both the rotating and stationary members of the bearing. Similar provision is made at the lower bearing of the main casting, at the safety bearing on the outer diameter of the table, and at all the bearings in the driving mechanism. After being drained from the outer lips of the bearing surfaces, the oil passes through a filter and is then returned to the reservoir to be used over again indefinitely.

Shortly after the machine was erected, this oiling system was tested; a pump was provided capable of giving 60 pounds pressure to the square inch. Such pressure, however, was found to be entirely unnecessary, as the head of oil in the barrel which furnished the supply reservoir was sufficient to furnish a copious supply of lubricant to all the surfaces. This head amounted to only about two feet, so the pressure was less than one pound to the square inch.

This machine differs from others which have been built for somewhat similar purposes in the construction which gives a stationary center to the revolving platen and in the fact that there is nothing which corresponds to the housings and cross-rails which are usually considered as a necessary part of a boring mill. This machine is designed to use portable tools and housings entirely. The work and tools may thus be set up in a variety of different ways. A tool holder may be clamped to the stationary part *A* in the center to take a cut on the inside diameter of a casting fastened to the revolving table. If the work is too large to admit of this being done, this tool holder may be mounted on a supplementary plate which has been furnished to extend the diameter of this stationary central part. By this means the radius of action of a stationary tool may be increased to bore a hole of about thirteen feet in diameter. For still larger boring the work may be mounted on the floor plate outside of the machine, while the tool post or housing is fastened to the revolving platen near its outside periphery. In working on the outside diameter of castings, the work may be fastened to the stationary center while the tool revolves about it, or on larger work the casting may be mounted on the platen while the tool is clamped to the stationary floor plate. Later on, provision will be made for boring the hubs of rotors and similar parts while the outside surface is being machined. For this purpose a boring bar provided with an individual drive will extend up through the opening in the stationary plate, which is normally filled by gage plug *N*. On this revolving boring bar will slide a head on which the cutters are mounted. Means will be provided for feeding this head up or down the revolving bar. Thus the outside and inside surfaces of the rotors may be finished, each tool working at its proper cutting speed.

Fig. 2. The Machine in Process of Erection.

The equipment of portable tools at present provided comprises the tool post or housing shown in outline in Fig. 1; the boring, drilling and milling machine which was illustrated among new tools in the October issue of MACHINERY; and a portable slotting machine. The first two tools were built by the Espen-Lucas Co., the latter by the Newton Machine Tool Works, both of Philadelphia, Pa. In the tool post in Fig. 1, the only motions are those necessary for the feed, which may be set to give the tool either a vertical or a horizontal movement. Speeds and feeds are thus seen to be entirely independent of each other. The other two machines, the boring drilling and milling machine and the slotter, are of course self contained units and may be used either in conjunction with this boring mill (which then simply acts as a face plate for holding the work or tools and indexing them to the proper position) or on any other work about the building.

A boring machine or revolving floor plate of this type pos-

sesses certain very evident advantages. Rotors and stators of electrical generators and work of a similar character may be practically completed at one setting by using this machine in combination with portable tools. Again, in work of this character and with tools of this size, it is practically impossible to keep such a machine at work continuously, and there must be long periods when it will be inactive. At such times the platen will simply form a part of the main floor plate of the building, while the portable tools which are ordinarily used in connection with it will be moved away to other parts of the floor, where they may be employed on whatever work needs to be done at the time. The case is thus the same as if one could take the housings and cross-rails from an ordinary boring mill and use them for other purposes when the machine as a whole was not needed, at the same time stowing away the useless parts of the machine so as to leave its place free for whatever work it might be expedient to do there. These considerations suggested to President S. S. Wheeler of the Crocker-Wheeler Co., the main features embodied in the machine.

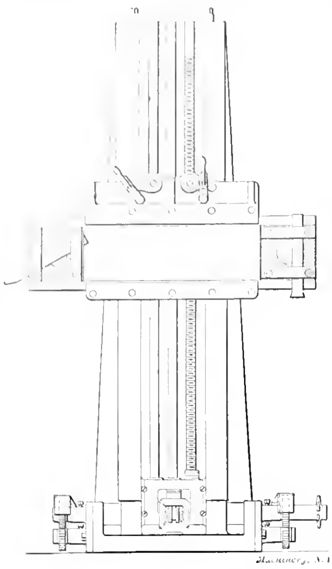


Fig. 4. Portable Tool Post.

Referring to Fig. 1, the weight of base casting *A* is 32,000 pounds; face plate *K* weighs 40,000 pounds; the total weight, exclusive of driving mechanism, is about 90,000 pounds. The face plate is 18 feet in diameter. The stationary center is 5 feet 6 inches in diameter but may be extended to 9 feet, as explained above. The limit in diameter for boring on this machine is about 25 feet; the driving mechanism is so arranged that the surface speed will not be abnormally high for turning the outside of the largest casting which it is possible to easily fasten to the face plate.

A NEW VALVE GEAR EMBODYING A NOVEL MECHANICAL MOVEMENT.

A valve gear has recently been designed by Mr. E. J. Armstrong, of the Ball Engine Co., Erie, Pa., which has some exceptionally interesting features. The gear is now used by the Ball Engine Co. on their four-valve medium-speed engines, in which rotary or Corliss valves are employed. In engines of this type the speed of rotation is sufficient to allow the use of a shaft governor so that the admission and cut-off of the steam can be controlled by a shifting eccentric under the influence of the governor. It is also desirable, at the speeds at which such engines run, to employ a valve gear that will give a positive opening and closing of the valves without the use of the hook cut-off gear and dash pots employed on Corliss engines of the regular type. The gear to be described gives a positive motion to the valves and is so designed that it opens and closes them promptly, but after they are closed allows them to remain in a stationary position until the beginning of the next stroke, when admission occurs.

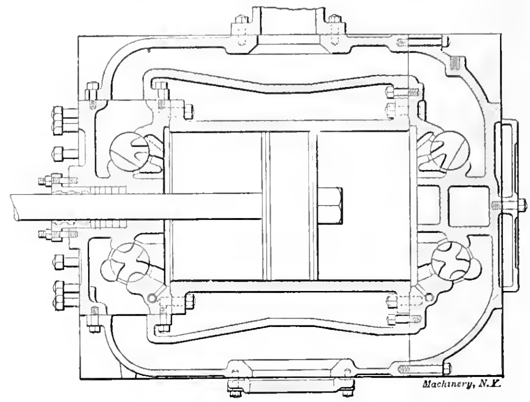


Fig. Section of Cylinder of Ball Engine.

In Fig. 1 is a longitudinal section of the cylinder of this engine. The admission valves are triple-ported, permitting a quick opening and closing, without too rapid movement of the valves. The multi-ported construction also gives a more uniform pressure on the valve seat. The exhaust valves are double ported.

The admission valves of the engine are controlled by a Robb-Armstrong-Sweet shaft governor, while the exhaust valves are operated by a fixed eccentric. The connections with the exhaust valves do not differ essentially from those usually employed on four-valve engines, since the desired conditions of opening and closing can be easily obtained by means of the usual rockers or wrist plate, and links connecting the rockers with the valve levers. The gear for operating the admission valves, and which is controlled by the shifting eccentric is a radical departure, however, and embodies what is probably an entirely new mechanical movement. In most shaft-governed engines of the four-valve type, the admission valves move at all times except with very late cut-offs, and the greatest strain of moving them while unbalanced by the steam pressure comes as the eccentric passes its centers, causing

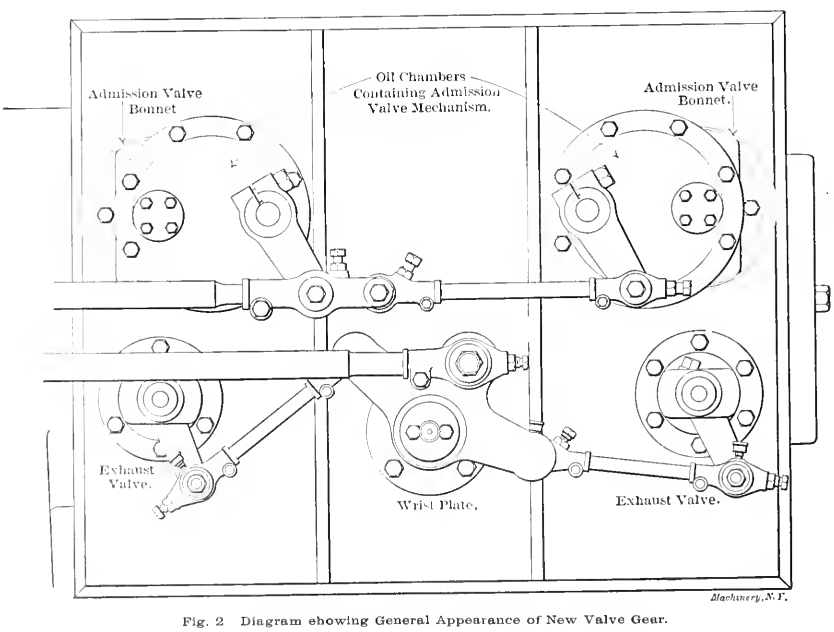


Fig. 2 Diagram showing General Appearance of New Valve Gear.

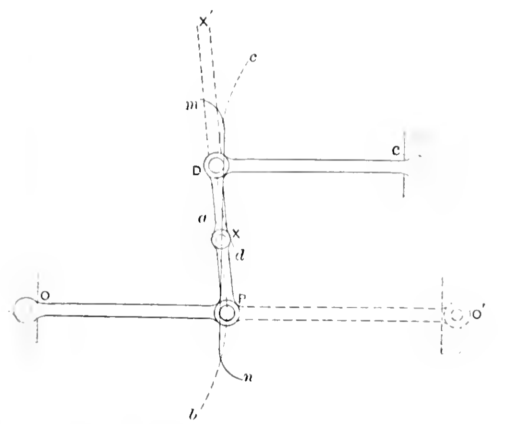


Fig. 3. The Watt Parallel Motion, which is the Basis of the New Valve Gear.

a tendency to pound. As previously stated, however, the new Armstrong gear allows the valve to remain stationary, between the time of closure and the time when it must move to admit steam, which reduces the strain upon the gear. The motion is so arranged, moreover, that when the valve does move to admit steam the eccentric is at the middle of its stroke when all slack has been taken up and so does not produce a pound.

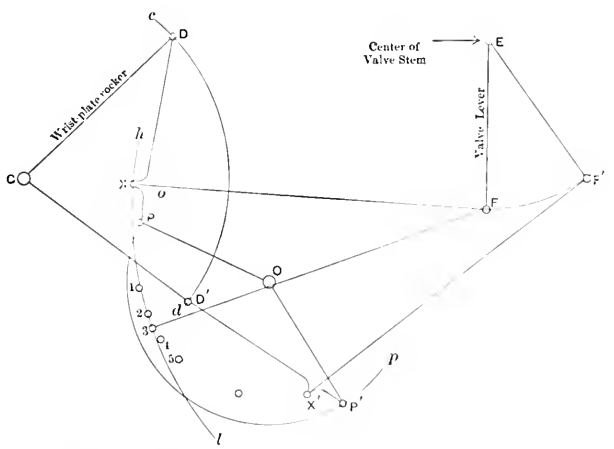


Fig. 4. Diagram showing Layout of Valve Gear as previously made.

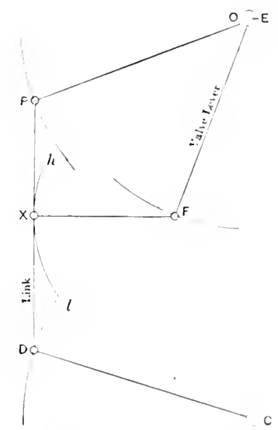


Fig. 5. Diagram of Improved Valve Gear.

The essential features of the valve motion are embodied in the rockers, levers and their connections upon the cylinder, which take the place of the usual Corliss wrist-plate and connections. The motion for operating the admission valves is a modification of the well-known Watt's parallel or straight-line motion, shown in Fig. 3. It consists of two levers *C D* and *O P*, pivoted at points *C* and *O* and having their outer ends connected by links *D P*. If the levers are of equal length, a point *X* located upon the links midway between points *D* and *P* will move approximately in a straight line, through a certain range of motion. If, however, the links should oscillate through too great a range of motion, point *X* would deviate from a straight line and the path that it would trace throughout its total movement would be line *mn*, Fig. 3. It will be noted that the central portion of this line is straight, while the upper and lower ends are curved, where the deviation from the straight path occurs.

It is possible to produce modifications of this motion, as for example, one lever may be longer than the other, in which case the position of the point upon the link *D P* which will trace a straight line, would be located either above or below the center of the link, according to the proportions of the levers.

A little consideration will show that any point upon the link *D P*, Fig. 3, between point *X* which traces a straight line, and the ends *D* or *P* of the links, will necessarily trace a curved path, being governed in its motion more by the action of one lever than it is by the action of the other. This fact has been taken advantage of in the designing of a valve gear previously used by the Ball Engine Co., and which has operated successfully. A diagram of this gear is shown in Fig. 4. One arm of a rocker corresponding to the wrist plate of a Corliss engine, is represented by the line *C D*. This rocker pivots on point *C* and is connected by link *D P* to a second rocker pivoted at point *O*. The two rockers *C D* and *O P*, and the connecting link *D P* constitute the Watt straight-line motion; only, the point *X* upon the link *D P* is so located that it will trace approximately the arc of a circle *h l* instead of a straight line.

The connection with the valve lever attached to each of the admission valves of the engine is *X F*, point *E* representing the axis of the valve. We will now suppose point *D* at the outer end of the wrist-plate rocker to move downward on the arc *c d*. The other rocker *O P* will consequently move downward, the end *P* tracing a curved path *o p*. Point *X* on the connecting link will follow a curved path during a portion of its travel, which path is the arc of a circle having its center at the point *F* of the valve lever. The valve lever will therefore not oscillate as long as point *X* of the connecting link travels on this arc, as it does through a certain range of motion, in accordance with the same principle that point *X* in Fig. 3 traces a straight line within a certain range of motion. Beyond this range, however, point *X* in Fig. 4 will depart from the arc of the circle having *F* as a center, and the valve lever will then oscillate to the right, opening the valve. This

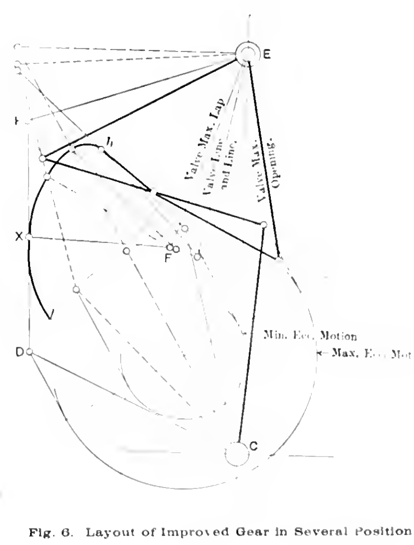


Fig. 6. Layout of Improved Gear in Several Positions

departure from the arc occurs at point 3. Successive positions of point X are indicated by the small circles 1, 2, 3, 4, etc. When the end D of the wrist-plate rocker has reached its extreme position, it will be at D' and then point P will be at P', point X at X' and point F of the valve lever at point F'.

The new gear that the Ball Engine Co. have just brought out embodies the same principle as the gear just described, which as explained is a modification of Watt's parallel motion. It is, however, arranged in a much more compact form; so compact, in fact, that the various levers and connections are encased in a small cast iron cylinder filled with oil and attached to the bonnet of each admission valve.

The modification of the Watt parallel motion used in the new gear consists in placing both levers on the same side of the connecting link as indicated by the dotted lines in Fig. 3, where the lever is shown in position $O'P$. With such a construction, however, the motion can be used to trace a straight line only by extending the link DP beyond one of the levers so that the point which is to describe the straight line will be located in a position indicated approximately by X' in Fig. 3. Any point as X located upon the link between the two levers will necessarily follow the arc of a circle within certain limits of motion, and then, as before, will depart from this path, following a curve of smaller radius.

Fig. 5 shows in outline the arrangement of this modification as worked out in the new type of gear. The different elements are lettered in Fig. 5 to correspond with the letters of Fig. 4. CD is the rocker which derives its motion from the eccentric rod, and serves the same purpose as the wrist-plate of the Corliss engine. It is connected by the link DP with a second lever, PO, which is pivoted upon and turns loosely upon the valve stem E. The central point X on the link PD describes the arc of a circle when the two levers oscillate back and forth. Point X is connected by the link XF with the valve lever FE which is keyed to the valve stem at E. In this motion, as before, point F is the center of the arc hl, traced by point X. As before, point X follows this arc hl only within a certain range of motion, and when this range is exceeded it begins to describe an arc having a shorter radius, the lever EF, therefore, begins to move to the right, and steam is admitted. When the mechanism has reached its extreme limit of motion and begins to move in the opposite direction again, the valve lever EF begins to move to the right, closing the valve and then remains stationary during the balance of the movement gear. In Fig. 6 the motion is shown plotted with the levers and their connections in several positions and the path hl of the point X is drawn throughout the range of motion so as to indicate the way in which the radius changes at the point where the valve is to open. Fig. 7 is made from a working drawing of the gear and shows the levers which operate one admission valve.

The Robb Engineering Co., Amherst, Nova Scotia, are the Canadian builders of this type of valve gear.

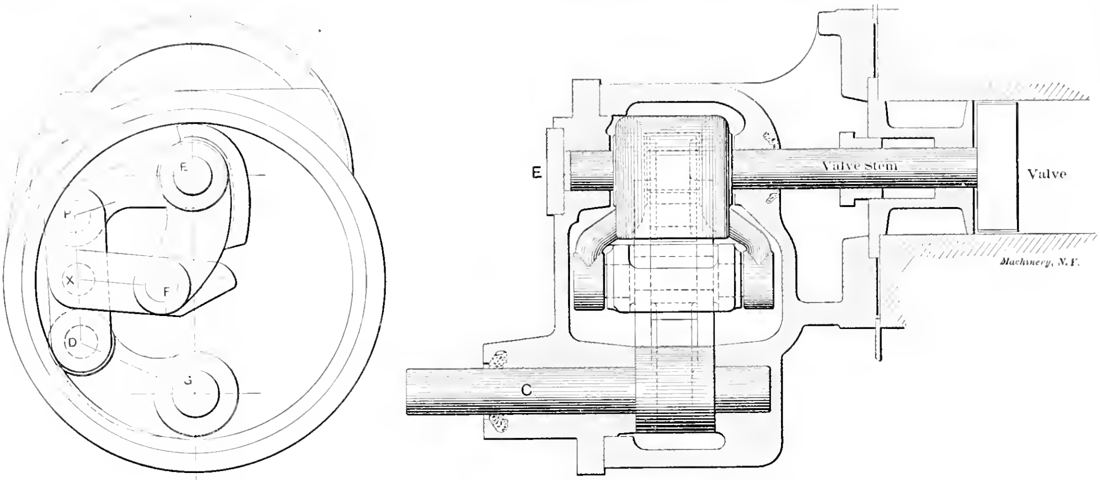


Fig. 7. Arrangement of Levers and Section of Bonnet and Valve Gear Chamber, the latter containing Oil.

THE DATA SHEET FOR NOVEMBER.

The table of squares of mixed numbers furnished with this issue of MACHINERY may require a little explanation, as regards the use of the column marked "End Figures." Supposing, for instance, we wish to find the square of the fraction 4 17-32. We follow down the column marked 4 until we come to the row containing the values for 17-32. The quantity given here is 20.5322. Following along this row to the last column, we find given the end figures 265625. This is to be suffixed to the previous figures, giving as a result the quantity 20.5322265625 as the exact result for the square of 4 17-32. In the same way the square of 11 23-64 is 129.035400390625. Again, the square of 2 1-16 is 4.25390625. These figures are carried out to an exact result.

Mr. G. R. Carothers, of Philadelphia, Pa., who computed the table, has found it especially valuable in making the calculations necessary for locating bushings in jig making. The problem of finding the hypothenuse of the right angle triangle when the length of the two sizes is known is of constant occurrence. The use of the table appreciably reduces the labor of finding the hypothenuse. For instance, supposing one side of the triangle is 2 3-8 while the other side is 4 13-16. The operation of obtaining the hypothenuse is as follows:

$$2\tfrac{3}{8}^2 = 5.640625$$
$$4\tfrac{13}{16}^2 = 23.16015625$$
$$28.80078125$$
$$\sqrt{28.80078125} = 5.3666 +$$

The mathematical work is thus reduced to one addition and the extraction of one square root.

* * *

The growth in favor of concrete for chimney construction is indicated by the fact that a little over one year ago the highest concrete-steel chimney was that built for the Pacific Electric Co., at Los Angeles, Cal. It has a height of 158.5 feet above the ground level and 174 feet above the foundation, and has an inside diameter of 11 feet. Since then the Portland General Electric Co. has built a concrete-steel chimney 230 feet high, having a flue 12 feet in diameter. Another built for the Tacoma Smelting Co. in Tacoma, Washington, is 300 feet high and has a flue diameter of 18 feet. But this latter will soon be eclipsed by one in erection at Butte, Montana, which will be 450 feet high when completed. The concrete-steel has a number of advantages for chimney construction, one of which is that it presents a smooth surface both on the exterior and interior; another, that it is a good non-conductor of heat, and still another, is that it requires no lining, being able to resist any temperature up to 1,500 degrees F., according to the statement made by Mr. George C. Mason in an article on the design and construction of tall chimneys of reinforced concrete, which appeared in the October issue of the *Journal of Electricity, Power and Gas.*

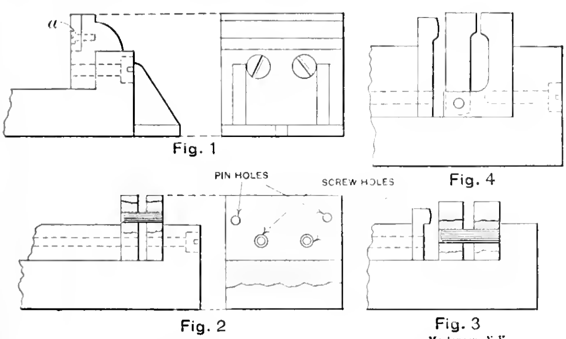
MILLING MACHINE FIXTURES.—1.

E. R. MARKHAM.

The principal consideration, when designing fixtures that are to be fastened solidly to the table of a milling machine, should be to have the table firm enough to admit working the machine and cutter to their limit. In fact, the fixture should be stronger than the machine itself, and able to resist any possible strain that the cutter can exert.

While fixtures should be strong, the movable parts should be so made as to be easily manipulated. All bearing and locating points should be accessible to facilitate the removal of chips and dirt. These not only make the work out of true and small for gage, but chips are pressed into the surfaces, causing chip marks, which every workman despises.

The first fixture to consider is the milling machine vise, which has a stationary and a movable jaw, against which are placed removable jaws, held in place by means of screws. The stationary-removable jaw generally has connected with it any shelf, pins, or means of locating the pieces to be machined. The reason for attaching them to this jaw is that this portion of the vise is not movable, and is, or should be, stiff enough to resist without springing any pressure that may be exerted by means of the crank and screw. The jaw attached to the movable slide part of the vise, on the contrary, is liable to alter its location slightly under strain, especially when the vise becomes worn.



Special Jaws for the Milling Machine Vise.

For some purposes, where but a few pieces are to be milled, or where the character of the pieces is such that there is not much liability of the jaws wearing, and thus affecting the accuracy of the pieces, it is safe to make the jaws of cast iron. If, however, there is a considerable strain on the jaws, it is advisable to make them of steel and harden them. For most purposes, jaws made of a good grade of machinery steel and properly case-hardened answer as well as those made from tool steel, and cost only a fraction as much for stock.

If possible, the piece to be machined should be held in the jaws below the level of the top of the vise in order to avoid springing the jaws out of a vertical position, as would be the case if the piece were above the level of the top of the vise. Occasionally pieces are so shaped, however, that they have to project considerably above the top of the vise jaws, in which case the jaws may be made with a rib which extends over the top of the vise and rests on the piece, as shown in Fig. 1. This furnishes a brace and prevents the springing that would prove harmful to almost any piece of work that it would be safe to hold in a vise while milling.

As it would prove quite expensive if many jaws of this style were made from steel, they may be made from cast iron, and a plate of steel placed where the work is to rest, as shown at *a*, Fig. 1. After the steel plate has been cut to shape and the locating device attached, the jaw may be hardened. If the devices mentioned are pieces which must be attached to the jaw, or pins which enter holes in it, they must be removed when the jaw is hardened. They may be hardened separately and attached afterward, as it would not do to harden two pieces which were screwed together or to harden a jaw with a pin in it.

At times it is necessary to hold pieces so that they rest on shelves on each jaw or are located by pins in both stationary and movable jaw. Generally speaking, it is advisable to construct special fixtures for such pieces, provided the degree of accuracy and the number of pieces warrant the outlay. However, if the pieces must be held in jaws in the vise, some method should be found to prevent the movable jaw from rising when pressure is applied, in the operation of "tightening up."

If the jaws are reasonably thick, large pins may be used, one near each end of the jaw, as shown in Fig. 2. These pins must be forced solidly into one jaw and fit closely in the other. Another method which works nicely is shown in Fig. 3. In this case the movable jaw proper is connected with the stationary jaw by means of pins, or a slide of different design. It is not, however, attached to the movable slide of the vise, but a hardened piece of steel is attached to this and bears against the movable part of the jaw. Many other forms are made, one of which is shown in Fig. 4. The front portion hinges at the bottom, and is pressed against the work by a movable slide. In all such holding devices, however, chips are liable to get between the various parts, decreasing their efficiency.

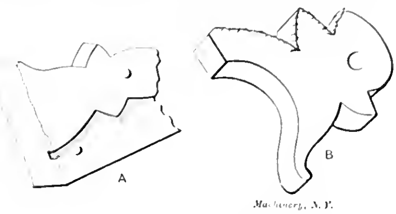


Fig. 5. Arrangement of Fixture or Vise Jaw to Accommodate Burr

When making any form of holding device, it is necessary to provide a place for the burrs that are a result of previous operations, unless they are removed by a process of filing or grinding. In many cases these burrs will be removed by future operations if it is possible to provide a place for them so they will in no way affect the accuracy of the piece. For this reason milling machine jaws and other fixtures are cut away in places to allow the burrs a place to go, as shown in Fig. 5 at *A*. At *B* a piece of work is shown with the burr mentioned.

It is the custom in most shops to provide a liberal supply of oil, or other lubricant, for cutters when milling work that requires lubrication. In many cases this fluid is used to wash out the jaws or fixtures after removing a piece of work. As this supply is used over and over, however, it is liable to become thick and gummy, and apt to prove harmful rather than helpful, unless the operator watches his fixtures closely. In some shops compressed air is used to blow chips from the working surface, and in many cases "works like a charm." On certain jobs nothing seems so effective as the hand and finger method for cleaning the surfaces of the fixtures.

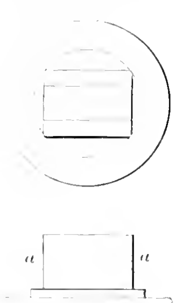


Fig. 6. A Difficult Piece of Straddle Milling.

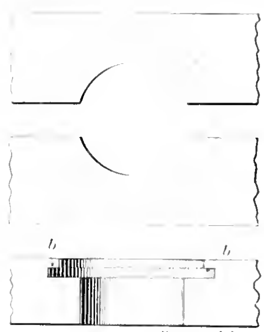


Fig. 7. Arrangement of Vise Jaws to hold Piece shown in Fig. 6

At times it is necessary to change existing methods in order to accomplish the desired result. The writer recalls a piece of work consisting of a flange, as shown in Fig. 6, having projecting portions, *a a*, which were to be straddle-milled. The jaws of the vise used to hold this piece had circular grooves,

b b, Fig. 7, which were thought necessary to properly hold the piece, since the pull of the cutters was in an upward direction; but these grooves made an excellent place for a deposit of chips, and as it was a difficult matter to clean them, and as the operator was working by the piece at a rather low rate, the edges of the flanges of the piece being milled became badly scored, and required an extra operation in the turret lathe to remove the marks. To overcome this difficulty, the projecting lips of the vise jaws were cut away and the direction of rotation of the cutters reversed, the overhead belt being changed so that the cutters would run onto the work, thus holding the work securely down on the seating surface of the jaws.

It sometimes happens that the opening in the vise is not sufficient to take in a long piece of work, in which case the jaws may be made of a form shown in Fig. 8. At other times the vise may be used with the movable jaw of the original form, and with the stationary jaw arranged as in Fig. 9. In this case a flat piece of steel is attached to the outside of the

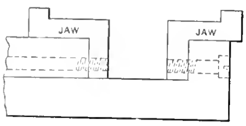


Fig. 8. Offset Vise Jaws.

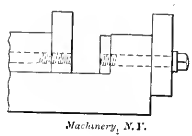


Fig. 9. Extended Vise Jaws.

jaw by means of screws which are a snug fit in holes drilled and reamed in both the auxiliary and stationary jaws of the vise. It is apparent that such an arrangement does not allow great accuracy, as the jaw on the end has no backing, and consequently will easily spring, yet there are instances where it answers the purpose as well as a costly fixture.

If milling machine vises are drilled for screws that hold jaws in such a manner that the jaws will readily go on any vise, much valuable time may be saved. If we are equipping a shop with new machines, this may be readily accomplished, as we may order vises drilled alike and corresponding with some vise already in use, and to which a number of pairs of jaws are fitted.

At one time when given charge of this class of work I looked over my vises and found that but few were drilled so the jaws would interchange. To avoid waiting, I plugged the screw holes in the vises that were different from several that did allow of interchange and drilled them so any jaw that fitted one would fit the other. Of course it was neces-

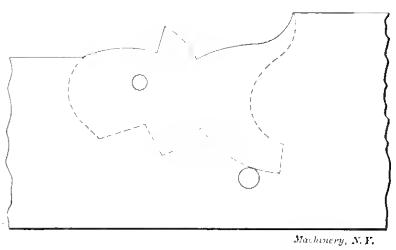


Fig. 10. An Outlined Vise Jaw.

sary to plug the holes in the jaws and redrill and tap them also. But I was amply repaid for my trouble. Of course I found that the spindles and tables of the machines did not all compare and as a consequence it was necessary many times to slightly alter a guide pin or a shelf, but this did not amount to anything compared with the disadvantage of a long wait when two or more jobs were wanted "right away" and then finding that all must be done on the same machine.

The vises ordinarily furnished with milling machines are opened and closed by means of a screw. Unless it is necessary to apply considerable pressure to the piece being held, this form of vise will not work as quickly as desirable where cheapness of production is a factor. To overcome this objection, vises are made so the slide may be opened and closed by means of a cam and lever, and unless there is much variation in the size of pieces being machined the cam will cause the work to be held sufficiently firm. The work may be placed in and taken out in this way much more quickly than when a vise operated by a screw is used. In fact, where such a vise will answer the purpose, it will be found as cheap to operate and as satisfactory in results as special fixtures; and the jaws necessary when starting a new job are, as a rule, much cheaper than special fixtures.

When it is necessary to cut in the vise jaws the shape of the piece to be milled, it may be done by passing the mills to be used through the jaws as shown in Fig. 10. The pins, or other appliances for holding the work, should now be added, after which they may be removed and the jaws hardened.

Ordinarily such parts of tools as milling machine jaws are made from machinery steel, but I prefer open-hearth steel, which does not contain over 25 or 30 points carbon. This may be casehardened nicely in oil with little or no liability of springing, as the depth of hardness necessary does not call for extreme heat, which causes the steel to go out of shape and also opens the grain of the steel and renders it more liable to become indented should a chip be pressed against the surface.

The jaws may be packed in the hardening box with a mixture of charred bone and wood charcoal—equal quantities—and run five or six hours after they are red hot. Then they may be removed and dipped in a bath of oil, working them up and down lengthwise in the oil until the red has entirely disappeared, after which they may be lowered to the bottom of the tank and allowed to remain until cold.

If for any reason it is necessary to harden the piece deeper than can be done in the length of time mentioned above, then the red-hot jaws may be exposed to the action of the carbonaceous material for a greater length of time. If the jaws are made from the grade of stock mentioned, and are given a low heat, there should be no springing during the hardening process.

* * *

THE PACKING OF MACHINE TOOLS FOR SHIPMENT.

T. S. BENTLEY.

Machine tools and similar articles, which are of considerable value and liable to injury if carelessly handled, require specially careful packing to insure their delivery in perfect condition; yet adequate precautions are often omitted. The faith which some manufacturers appear to repose in the gentleness of those through whose hands their productions have to pass, would be really touching if it were not so obviously misplaced. Many of them seem to suppose that if they stencil the legend "This side up" on the case, they need have no anxiety about the contents shifting, and may neglect all precautions with impunity. Others think it unnecessary even to adopt the warning notice, yet dispatch the machine packed in such a manner that it is almost certain to be badly damaged if the case should be turned over or laid on its side.

Those who have the misfortune to receive the goods at the end of a long journey by rail and sea, are in constant trouble through this inexplicable want of foresight on the part of the makers. Cases only too frequently come to hand bearing unmistakable evidence of having been turned over, dropped, or swung violently against some solid obstruction when suspended. Accidents and rough handling occur with sufficient frequency to be ranked among the contingencies which must be expected and guarded against by all possible means; while the most skillful packing will not always prevent damage, it will often do so, and in any case is certain to minimize risk of breakage. As a matter of fact, however, many machines on their arrival are found to be broken when there are no signs of rough treatment or accident, and the fault is clearly on the part of those responsible for the packing.

Now it generally happens that the damaged machine is wanted for immediate use, and the delay is equally vexatious to the purchaser, whether he can rectify the injury himself, or is forced to await the arrival of replaced parts from the makers. If the trouble is manifestly the fault of the transport companies, the purchaser, however vexed he may be, can make no complaint against the makers; and has usually no means of knowing who is really responsible, or at what part of the

journey the damage occurred. When the packing is clearly to blame, however, his annoyance is focussed upon a definite object; and the matter becomes a serious one for the maker of the machine, for he is not only expected to make good the injured parts, but in addition, his prospects of further business will be prejudiced by the remembrance of the inconvenience or loss occasioned through the negligence of those connected with him.

Merchants and factors who import for re-sale are often put in a very awkward position by reason of occurrences of this kind, as they are dependent on the punctual arrival of the machines in perfect condition to enable them to fulfil their own undertakings with regard to delivery to their customers. Though they cannot prevent delays arising in this manner, they are apt to be held responsible by their clients, and knowing that, they naturally resent being put in a false position through another's fault.

Another thing which is most annoying is to find when a tool is unpacked, that the bright parts are badly rusted, and the appearance of the machine thereby hopelessly spoiled. This may happen through lack of care in applying the slushing oil; in a defective preparation being employed; or through the packing materials being damp when used. Paper which is not thoroughly dry may easily cause trouble in this way.

Some makers seem to imagine that the parts of a machine will travel safely if merely put into a box with some woodwool. While this is a very useful material for packing light pieces, it requires to be stuffed in very tightly, and for heavy parts is quite inadequate. The same remarks apply to sawdust, but in an even greater degree.

While it is impossible to give any hard and fast rules as to the best methods of packing, there are a few points which cannot be too carefully borne in mind. Among them are the following:

1. The case should be made of sound wood, tongued and grooved, and of thickness proportioned to the weight of the machine; when in doubt as to what is necessary, err on the side of strength.

2. It is not sufficient to secure a machine by bolting it down to the bottom of the case. This is often done, and broken bases not infrequently result. The machine should be stayed rigidly in every direction by struts of ample thickness bearing against the solid frame of the machine. Where they bear against the sides of the case, they should not abut against one board only, but should have another piece interposed, which bears crosswire and distributes the pressure over a considerable area. If this method of staying is properly carried out, it effectually secures the machine from moving, and obviates dangerous local stresses. In fact, the best packers rely entirely on this system and use no bolts whatever.

3. The bright parts should be well coated with some good brand of "slushing oil," and special care should be taken that every portion needing protection is properly covered. This is most important, and does not always receive the attention that it deserves; as it is very easy to overlook surfaces which happen to be underneath, or otherwise out of the line of sight, but which require protection all the same. A reliable slushing oil will in most cases be found preferable to either vaseline or the old-fashioned mixture of white lead and tallow. The latter is still used to a considerable extent, and even specially called for by some shipping specifications, but is open to several objections. In the first place, it is very difficult to remove, which causes a good deal of inconvenience to those who have to erect the machines. It is also very unreliable as a rust preventer, and is often found to spoil the appearance of the tool by discoloring the metal upon which it has been spread.

4. For journeys of ordinary length—such as across the Atlantic—no special precautions are usually necessary to guard against damp if the hints named above have been carried out. In wet seasons, however, trouble may be caused through the case being exposed to heavy rain prior to shipment. In some instances this danger is provided against by cautious manufacturers who cover the top of the case with thick waterproof paper, which acts as a roof and keeps the rain from penetrating. This simple expedient is not an expensive matter, and though not generally required, on occasion proves a valuable safeguard.

5. When a machine is taken apart and packed in pieces, it is important that each part be well secured so that it cannot possibly shake loose. The more delicate portions are best packed by themselves in a separate inner case, so that even if anything should get adrift no serious damage could be done.

There is one other matter worthy of passing notice. A very good plan which is adopted by certain makers to lessen the risk of their machines being dropped or turned the wrong way up, is to provide special facilities for slinging the cases in the desired position. As it is natural for everyone to follow the "line of least resistance," it is safe to assume that those who have to handle the cases will do so in the easiest way, and this fact is utilized in the manner indicated.

If the above points were always put into practice, there would be a vast diminution in the amount of trouble experienced through machines arriving in more or less damaged condition; much mutual recrimination would be prevented; and the gain to all parties concerned would be great.

* * *

TANTALUM.

Tantalum is a rare metal discovered by Ekeberg in 1802. It is one of the hardest elements known, and combines with extreme hardness great toughness and ductility. Tantalum filaments have been used with some success in incandescent lamps, and it would not be surprising if its physical qualities should make it useful in other directions. Recent tests made in the Siemens & Halske Works, as reported in the *Zeitschrift für Elektrochemie*, are interesting. A specially pure lump of tantalum was prepared and tested in the department of the works devoted to the manufacture of boring tools, with the following results:

1. With a file of specially hard and fine steel it could be filed, but the file itself suffered in the work.

2. A small chisel of specially hard tool steel, with a point 0.16 inch in breadth, was blunted at every blow of the hammer.

3. A water hardened steel tool marked the mass of tantalum, but the tool speedily lost its edge, and was unable to make any further impression upon the metal.

4. Two boring tools were made from fine grained cast steel, and hardened in quicksilver. One of these tools was of the usual section, the other was triangular. With the first of these tools the thin sheet of tantalum only 0.04 inch in thickness required 7 minutes for perforation, while with the second tool 10 minutes were required, turpentine being used in each case as lubricant for the cutting edge. In each case the cutting edge of the tool was blunted.

From these test results it follows that tantalum, containing only small amounts of impurity, hammered into sheets at a red heat, is equal in hardness to the best and most carefully finished steel. Tantalum, however, greatly exceeds this hard steel in toughness, for while these hard tool steels are brittle, tantalum can be rolled into sheets without injury.

* * *

The origin of most sayings is unknown, or is so obscured as to be very doubtful, especially where it has a local significance. A case in point is that of a well-known saying: "He will never set the North River afire." It is said to have originated in the days of Captain Payne, a freak inventor of the fifties. Captain Payne alleged that he had discovered a process of making illuminating gas from water by electrolysis so cheaply that the ordinary processes would be entirely overthrown. As it afterward turned out the scheme was a fake, but during the height of the excitement, when gas stocks fell to an unprecedented price, the newspapers predicted that water would become the common source of light and fuel, and that New York's heat and light would be drawn from the North or Hudson River. In other words, Captain Payne was thought able to set the North River afire—but he wasn't, hence the quotation originated with the doubters. But the accuracy of this may be doubted, for the British have a similar saying regarding the Thames River.

THE BURSTING STRENGTH OF CAST IRON CYLINDERS.

C. H. BENJAMIN.

Some years ago the writer reported to the American Society of Mechanical Engineers some experiments on the subject indicated by the title of this article.*

In some respects these experiments were unsatisfactory, as many of the cylinders failed at the flanges instead of splitting longitudinally. An attempt to remedy this by thickening the flanges only resulted in the formation of "hot spots" at the junction of shell and flange, with no material increase of strength.

In the same paper was developed a formula for the thickness of such cylinders which assumed the following form:

$$t = \frac{p\,d}{4\,S} + \sqrt{\frac{c\,p\,d^2}{S} + \frac{p^2\,d^2}{16\,S^2}}$$

where

t = thickness of shell in inches,
d = internal diameter in inches,
p = internal pressure in pounds per square inch,
S = tensile strength of metal in pounds per square inch.

The first term under the radical is in the nature of an allowance for binding or distortion of the shell from some lack of uniformity in thickness or in strength, the constant, c, being determined by experiment.

If $c = o$, the equation reduces to

$$t = \frac{p\,d}{2\,S}$$

the usual formula for thin shells.

An examination of several engine cylinders of different makes has shown values of c varying from .03 to .10 with an average value of .06. Experiments on nine different cylinders varying in diameter from 6 to 12 inches gave fairly uniform values for c with an average of

$$c = .05.$$

The metal of the cylinders was an unusually close-grained, tough cast-iron, having a tensile strength of 24,000 pounds per square inch. The tensile stress on the shell as calculated by the formula:

$$S = \frac{p\,d}{2\,t}$$

averaged about one-third of this, showing the inapplicability of such a formula to cast-iron shells.

In 1903-04 Messrs. A. H. Austin and R. A. Brown made another series of experiments of this character in the laboratories of the Case School, which throws additional light on the problem.

* Trans. A. S. M. E., Vol. XIX.

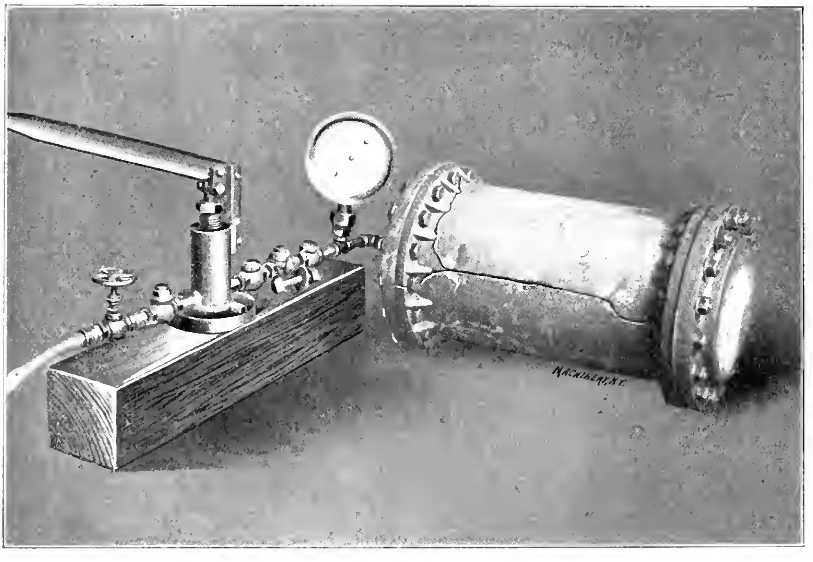


Fig. 1. Apparatus for Testing Cast Iron Cylinders.

The experimenters used practically the same apparatus as that described in the paper before referred to. Fig. 1 shows the force pump, the water pipe and check valves, the pressure gage and the cylinder in position for a test. Four cylinders were tested to rupture with water pressure, each cylinder having a length of 20 inches, an internal diameter of 10¼ inches and a thickness of shell of ¾ inch.

Fig. 2.

The flanges were of the same thickness as the shell and were reinforced by sixteen triangular brackets, as may be seen in Fig. 1. The covers were held to the flanges by sixteen soft steel bolts ⅝-inch in diameter, having a tensile strength of 80,000 pounds per square inch. The heads of the bolts were cut off on one side so as to bring the bolt holes close to the shell and avoid as much as possible the bending moment on the flanges.

Gaskets of straw board soaked in linseed oil and inserted in shallow counterbores were used to prevent leakage. The inside surface of the shell was coated with paraffin for the same reason. Former experiments had shown that water under high pressure would find its way through very minute orifices.

The cylinder heads first used were 1⅛ inch thick and reinforced by 8 radial ribs on the outside. These proved unsatisfactory, the first head breaking at 650 pounds per square inch and the second at 850 pounds. The ribs being on the outside were put in tension by the buckling of the head and had no value. As it was impracticable to put ribs on the inside, the head was thickened to 2⅛ inches at the center, as shown in Fig. 1, when no more trouble was experienced. The four accompanying illustrations show the four cylinders after rupture and the pressure per square inch at the instant of breaking.

It will be noticed that the fractures are all longitudinal, there being but little of the tearing around the shell under the flange, which was so marked a feature of the other experiments. It is evident that the brackets have served the purpose for which they were made in a way that no mere thickening of the flange could do. The metal used for these cylinders was a soft, gray cast-iron having a rather low tensile strength. In fact pieces cut from the shell of the cylinders and broken in the testing machine had an average value for S of only 14,000 pounds.

As tension specimens of cast iron usually show less than the real strength on account of bending the actual strength of the iron may be slightly more than this.

The average cross-breaking strength of samples from the shell was only 30,000, which is also low.

The following table shows in detail the dimensions and test pressures of the various cylinders. As before stated, the cylinders were all of the same diameter and length, 10½ by 20 inches.

BURSTING PRESSURE OF CAST IRON CYLINDERS.

No.	Thickness.			Bursting Pressure.	Value of c.	$S = \frac{pd}{2t}$
	Max.	Min.	Ave.			
1	.775	.757	.766	1350	.0213	9010
2	.783	.697	.740	1400	.0152	10200
3	.740	.703	.721	1350	.0126	9735
4	.770	.670	.720	1200	.0177	9080

Average value of c = .0167.

The average value of c is thus shown to be only one-third of what it was in cylinders with unsupported flanges. The values for S in the last column give the stress as calculated

Fig. 3.

by the formula for thin shells, and show that the stress due to bending cannot be neglected even with the reinforced flanges. This may be more clearly shown by solving for S in the formula given at the beginning of the paper:

$$S = \frac{p\,d}{2\,t} + \frac{cpd^2}{t^2}$$

where the first term of the second member gives the stress due to direct tension and the second term the stress due to

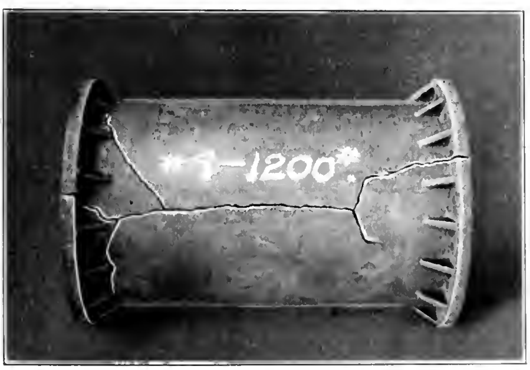


Fig. 4.

bending. Assuming the average value $S = 14{,}000$ as determined by the testing machine, we have for the four cylinders:

No.	S	$\frac{p\,d}{2\,t}$	$\frac{c\,p\,d^2}{t^2}$
1	14,000	9,010	4,960
2	14,000	10,200	3,800
3	14,000	9,735	4,265
4	14,000	9,080	4,920

The "accidental" stress, as it may be called, is seen to be about one-third of the whole.

The fractures in all of the cylinders were longitudinal, beginning at some weak spot near the center and extending either way, usually branching to two or more bolt holes at the flanges.

In this connection it may be of interest to notice a test recently made in the Case laboratories of a gasoline engine cylinder for a Peerless motor car. This cylinder broke around a circumference just above the lower flange when subjected to a hydraulic pressure of 1,600 pounds per square inch. The cylinder had an internal diameter of 4.25 inches and a shell thickness of 5-16 inch. The flange was 9-16 inch thick. The fracture showed a clean, close-grained iron. Assuming a tensile strength of 18,000 pounds per square inch and substituting values, we have $c = .024$.

The conclusions to be derived from these experiments are:

First, that when the cylinder flanges are unsupported, the initial fracture will be circumferential and close to the flange at a pressure very much less than that determined by the formula:

$$p = \frac{2\,t\,S}{d}$$

Second, that when the flanges are sufficiently braced to insure longitudinal fracture, a considerable allowance must be made for bending and other accidental stresses.

* * *

HYDRAULIC CLAMPING CYLINDERS.

FRANK B. KLEINHANS.

Considerable difficulty is experienced in large flanging machines in connection with the clamping cylinders. There are four of these around the main cylinder, each with a certain radial adjustment to suit the various dies with which they are used. The difficulty lies in the fact that these cylinders are connected to one valve, and when water is admitted to them the different plungers advance at different rates of

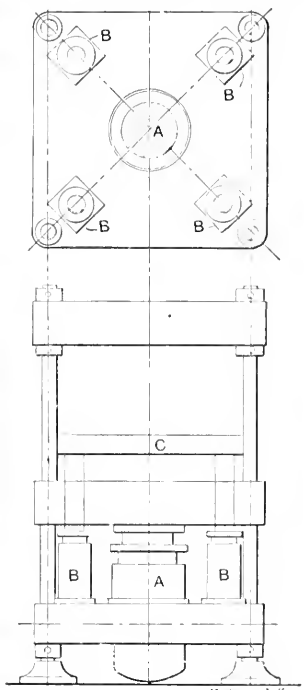


Fig. 1. Sketch of Flanging Machine, showing Main and Auxiliary Cylinders.

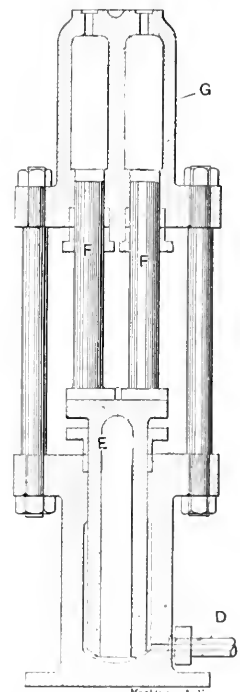


Fig. 2. Hydraulic Equalizer, for Operating the Auxiliary Cylinders in Unison.

speed. Under these circumstances it is impossible to raise the die in a level position and this makes it difficult to do certain classes of work. If it were possible to move all four of these plungers in absolute unison many operations could be performed at a much less cost than at present. Fig. 1 shows an elevation and plan view of the arrangement of the cylinders in a flanging machine. A is the main flanging cylinder and the four marked B are the auxiliary ones which operate the clamping die C. It is the operation of these last that causes the trouble.

An arrangement designed to raise these plungers together

is shown in Fig. 2. The pipe D leads from the operating valve to the lower cylinder of the equalizer. The pressure acts upon the plunger E and forces it up against four plungers F, the combined areas of which are a little less than that of E, the reduction being made to offset the weight of the plungers and the slight friction of the stuffing boxes. The top cylinder G has four chambers, each of which is independent of the others. Fig. 3 shows the connections between these chambers and the clamping cylinders of the press, the reference letters being the same for all the cuts. H is a valve chest at the top of cylinder G; J and K are relief and check valves respectively, and L is the supply pipe which replaces water lost by leakage from the system.

In the position shown, the plunger E is at the bottom of its travel and the four chambers in cylinder G are full of water, as are also pipes leading from them to the adjustable plungers B, which are at the bottom of their stroke. If now, water be admitted to the lower equalizer cylinder, the four plungers F are moved up equal distances, and force equal amounts of water out of their chambers through the piping to the clamping cylinders. The four plungers B must then move in synchronism even though one of them be supporting its full load while the others have no load at all.

There is one difficulty, however, which has to be avoided in this device. It is possible to obtain a daugerously intensified pressure. If all the load be concentrated over one of the clamping plungers, its corresponding chamber in the equalizer will have to take the full fourfold thrust of plunger E. To avoid this each chamber is supplied with a relief valve which

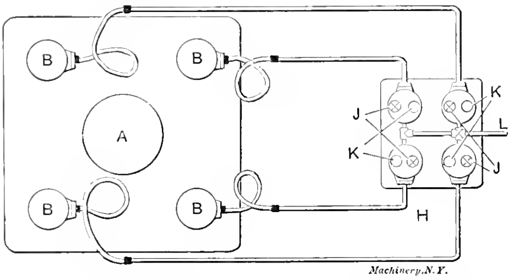


Fig. 3. Diagram of Piping between Equalizer and Flanging Machine.

rises from its seat when the pressure in the chamber exceeds that of the accumulator. Each chamber is supplied in addition with a check valve K which makes good any loss of water in the equalizer system by admitting a new supply from pipe L when the pressure is released in the chambers. As soon as the operating valve is open again, this valve is closed by the pressure of the water behind it.

* * *

It is somewhat impressive to learn that the gyratory motion imparted to a rifle bullet by the twist in the barrel may reach a peripheral velocity high enough to seriously test the cohesive strength of the bullet to resist the centrifugal stress; but that such is the case is indicated by the following, especially with the weaker metals like lead: For example, the twist in the United States 0.30-caliber rifle is one turn in ten inches, and the muzzle velocity of the bullet when fired with the regular charge of smokeless powder is about 2,300 feet per second. Assuming that the bullet does not strip in the rifling, it follows that it must spin at the rate of $\frac{12}{10} \times 2300 = 2760$ turns per second. The circumference of the bullet is $0.30 \times 3.1416 = 0.9425$ inch, which, multiplied by $2{,}760 = 2{,}601$ inches, or 216.8 feet per second peripheral velocity. The peripheral velocity of 216.8 feet per second, or 12,880 feet per minute, is one that would test the strength of cast-iron and rupture metal of less strength and much greater density. Hence it follows that there are two reasons at least for making high-velocity bullets of stronger metal than lead, one being to withstand the centrifugal stress and the other, and perhaps more important one, to resist upsetting in the barrel on account of the tremendous pressure required to overcome its inertia, especially where the bullet is greatly elongated, as is necessary to maintain a reasonably flat trajectory.

ON THE LOCATION OF THE PITCH CIRCLE IN WORM GEARING.

RALPH E. FLANDERS.

Mr. Perrigo* and Mr. Edgar,† in their recent contributions on this subject, have called attention to some important points in connection with this form of gearing. The writer feels, however, that the recommendations they make cannot be followed blindly, but must be applied with a full knowledge of the limitations within which these recommendations are useful. It is the purpose of the present article to point out these limitations.

Mr. Perrigo describes a worm and worm wheel which he has incorporated in the feed mechanism of a screw machine. Made in the way he describes, this worm and wheel have outlasted everything of their kind in his previous experience, and if the cases with which he mentally compares this one have no other important points of difference, his confidence is certainly justified. Unfortunately, this point is not covered, and so we are left without a solid foundation on which to base our judgment.

The feed worm of a screw machine, if it is of the class in which the worm is dropped out of engagement when the feed is released, does its work under peculiarly trying circumstances. The writer's experience in screw machine design has led him to believe that the proper proportioning of these parts is a matter of considerable importance. Consider the case of a bronze wheel and a hardened-steel worm working under the pressure of a heavy cut: When the worm is released from engagement with the wheel, under the pressure of this heavy cut, the sharp, hardened corner of the worm-tooth goes sliding down the face of its corresponding tooth in the wheel, giving it a last dig as it jumps by the corner. The necessity for quick handling demands that the momentum of the revolving

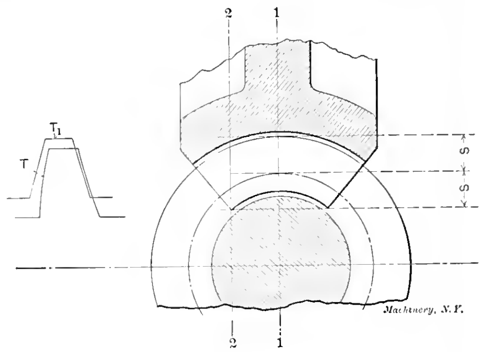


Fig. 1.

parts of the feed mechanism be kept as low as possible, so the peripheral speed of the worm wheel must be as low as possible in comparison with the rate of movement of the slide. This, in turn, requires that the worm work under heavy pressure. It is not practicable to locate the feed release between the worm and the clutch, especially if the feed is to be stopped automatically, because it is difficult to handle a toothed clutch under a severe torsional strain. Usually this problem is settled by a compromise whose success depends on the judgment of the designer; the per'pheral speed of the worm wheel is made as high, and consequently, the worm thrust is made as low as is possible without too great a sacrifice in rapidity of handling. In large machines this difficulty may be overcome by connecting the pinion shaft to the worm wheel by frictional contact, accomplished by tightening up a supplementary pilot mounted in front of the main pilot wheel; the automatic release is effected by stopping the rotation of the worm.

Another point that militates against the durability of this mechanism when a releasing worm is used, is the indeterminate location of the worm. While it is obvious that a worm cannot be adjusted in a direction parallel to the axis of the worm wheel, it is not generally realized that the center distance between its axis and that of the wheel cannot be varied without losing the perfect action which exists when the worm

* An Example of Worm Gearing, MACHINERY, June, 1905.
† The Worm Gear, MACHINERY, Engineering Edition, October, 1905.

is properly located. That this is so will be evident from Fig. 1. In this cut T_1 and T are sections of a worm tooth taken on lines 1-1 and 2-2, respectively. The section on 1-1 is evidently that of an involute rack tooth and so possesses the characteristic property of correct action at any center distance, so long as its straight face is in contact with the mating gear tooth. As we leave this section, however, and approach section 2-2, the tooth outline gradually loses its resemblance to the involute form and takes a shape in which positive location is absolutely necessary for correct action, as is shown by the curved sides. This variation from the involute shape is especially marked in worms of large helix angle and consequent high efficiency.

Now, if the worm is slightly separated from its correct location in the mating wheel and no sideways motion is allowed, it will be seen by observing the relative angularity of the outlines of the faces in the curves T_1 and T_2 that the contact will at once lose its character of line contact, extending across the full width of the gear, and will be concentrated in point contact on the extreme outer edge, where correct action is impossible except at the calculated center distance. For working under heavy pressures, then, it is necessary that the worm agree in shape with the hob which cut its mate, and that its axis exactly coincide with that of the hob when it was taking its finishing cut. These requirements may be met easily in high-grade work, such as is the rule in making a worm-gear drive for a gear-cutter spindle or an elevator, but such workmanship is very far from the haphazard fitting that a releasing feed worm must necessarily get.

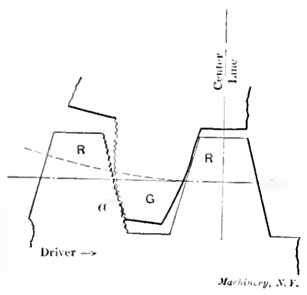


Fig. 2.

In looking over the cut of the screw machine with which the article we are discussing is illustrated, the suspicion struck the writer that the worm, or worms, must be of considerably greater helix angle than is usual in feed gearing. The unusual arrangement of a double reduction is employed, making use of two sets of worms and wheels in series. Unless the feed shaft rotates at high speed, or the feed is exceedingly fine, this must mean that the reduction in each set of gears is small, which in turn predicates a large helix angle and an efficient gear.

Mr. Perrigo must, then, give us more definite information if his experience is to be valuable as a permanent record in the matter of the location of the pitch line. Was his machine furnished with a releasing worm for a feed stop, and were the machines with which he compares it so equipped? How carefully was the worm fitted in the last machine and in the former machines? What are the helix angles of these worms and former unsuccessful cases? What materials were used in the different sets of gears which are under comparison?

Mr. Edgar has shown quite plainly that the advantage to be gained by lessening the diameter of the pitch circle on the worm is due to the fact that in such a case the contact between worm and wheel takes place for the most part after the teeth have begun to recede from each other. In Fig. 3 the worm, with its pitch line at $G H$, driving the wheel in the direction shown, will always make contact with it along the line of action, $C D$. The pitch line is located, as usual, halfway down the working depth of the tooth, and as may be seen, the contact is almost equally divided on each side of the center line. In Fig. 4, with the same reference letters, the pitch line has been located according to the rule proposed by Mr. Edgar, and the contact between the teeth is seen to take place almost wholly during the time when they are leaving each other.

Friction between two rubbing surfaces is due to the resistance imposed by the microscopic irregularities which exist on even the smoothest surfaces. In Fig. 2 are shown two teeth approaching each other, in which these irregularities are greatly exaggerated. R is the driving and G is the driven tooth. Evidently if these irregularities were as great as shown, the teeth would lock together and movement would be impossible; on the other hand, if G were the driving tooth, and the teeth were separating, there would be little to hinder their free movement. It is, then, desirable that most of the contact should take place when the teeth are leaving each other, to avoid friction, loss of power, and wear of tooth surfaces.

Fig. 1 shows the way in which Mr. Edgar proposes to locate the pitch circle of the worm. This circle is tangent to a line which lies at equal vertical distances from the extreme working points of the worm wheel tooth, and he locates the pitch line here because it is so located in a spur gear. To the writer it seems that there is no analogy between them. The pitch line of a spur gear is located at one-half the working depth of the tooth because it is required that a set of standard spur gears be interchangeable, a gear of any number of teeth meshing perfectly with a gear of any other number of the same pitch. This requirement is entirely outside of the sphere of worm gearing, so we may locate the pitch line at any point that will give favorable results as regards efficiency and durability.

The location of the pitch line affects the working qualities of the gearing in four ways, at least. With a worm of given diameter and pitch, and a wheel of given number of teeth and angle of contact, it determines the effective working area of the teeth in both members, the strength of the teeth in the wheel, the number of teeth in contact, and the nature of the contact, that is, whether it takes place during the approach or the release.

Fig. 3 shows a central section of a worm and wheel calculated in the usual manner. If a is equal to the pressure angle and angle $F D O$ is a right angle, a circle drawn from

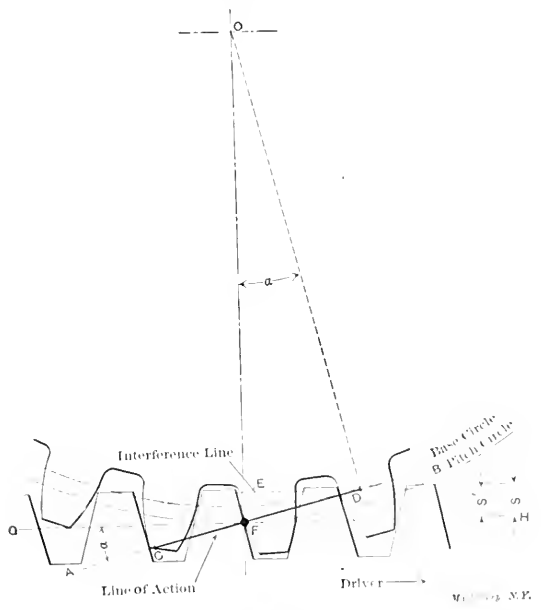


Fig. 3.

center O through D will be the base circle from which the involute curve is formed, and the line of action—the line in which the working contact between the teeth will take place—will lie in line $A B$. This line of action will evidently be limited at one end by C, the point where it crosses the outside diameter of the wheel at its throat, and at the other by D, the point where line $A B$ is tangent to the base circle, since the involute does not extend inside of the circle from which it is derived. It is plain, then, that all that part of the wheel tooth which lies inside of the base circle is clearance, and unfit for bearing surface, and that all of the rack tooth which extends above point D, or the "interference line," as it is marked, serves no useful purpose. This area of the worm tooth extend-

ing above the interference line, is seen to be slight for a thirty tooth wheel of standard design. An inspection of the cut will show that there are always two and sometimes three teeth in contact. The contact takes place about equally each side of the center line, inclining toward the favorable side, since line $F\ D$, on the release, is somewhat longer than $C\ F$, on the approach.

In Fig. 4, we may see what effect has been produced by increasing the addendum of the worm, as we are advised to do. In the first place, the interference line, through point D, is lowered so far that the useful area of the teeth has been greatly decreased. There is no working contact on the wheel teeth inside of the base circle, nor do the worm teeth serve any useful purpose above the interference line.

The strength of the wheel tooth has been decreased. The great length of useless worm tooth extending above the interference line has cut a deeper clearance into the flank of the wheel tooth, thus weakening it at the very point where it needs strength. On pages 68, 69, and 71, of the Brown & Sharpe "Treatise on Gears," will be found three illustrations which show this point very clearly. One case is that of a twelve-tooth worm wheel of standard design, which gives a badly undercut flank. In the next illustration the worm wheel has been hobbed according to Mr. Edgar's rule, and the result is worse than in the first case. The last illustration shows the pitch line thrown clear to the outside diameter of the worm, this being advised as the proper remedy to secure a tooth of sufficient strength and bearing surface.

Referring again to Fig. 4, the number of teeth in contact has been reduced until there is only one constantly in use, though two are in position to work most of the time. The single gain to be derived in return for the advantages that have been lost lies in the fact that a greater percentage of the line of action lies on the releasing side of pitch point F than before, since $F\ D$ is noticeably longer than $F\ C$.

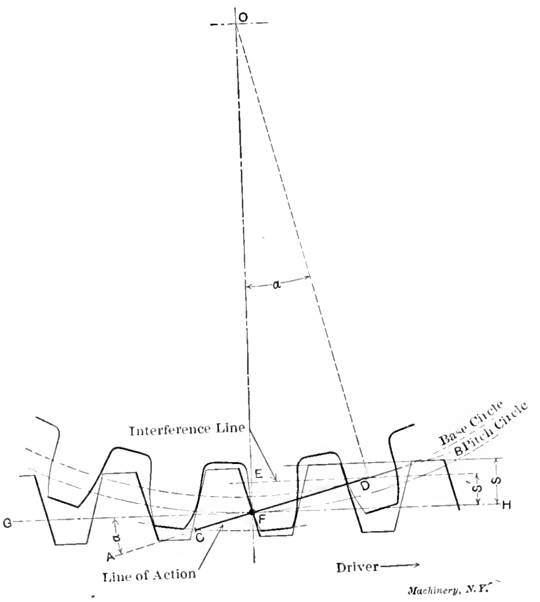


Fig. 4.

Of course only the action on the center line has been analyzed. The writer has studied the action at sections made in different places in the worm-wheel face, and it looks as though the conditions at the center line were a fairly good index of what is going on nearer the sides. The line of contact appears to rise slightly toward the outside of the worm as it leaves the center (going toward the leading side of the worm), and then drops again toward the edge of the wheel. On the retreating side of the worm the contact drops continuously. This tends to minimize the effect that the width of the wheel has on the action.

How, then, should the pitch line be located? It seems to the writer that the problem is so involved that in a case of any importance the designer should not trust to any empirical rule, but should plan each case with reference to these four points: area of bearing surface in the teeth, strength of the teeth, number of teeth in contact, and location of contact, whether in the approach or the release. To these should be added a fifth point, more important than any of the others, as far as efficiency is concerned, and that is in relation to the helix angle of the worm: it should be as large as possible.

Taking all these points into consideration, it would seem that, for worms and wheels made as they usually are for ordinary service, from ordinary materials, and with ordinary carefulness of workmanship in making and fitting, it is hardly worth while to bother about changing the location of the pitch line for the sake of having the contact on the release. It introduces too many other complications into the problem. Still, if there is any one who wants to try the effect of altering the worm and wheel dimensions with this end in view, here are a few suggestions in the shape of formulas to add to those of the two contributors who have previously written on this subject.

Let N = number of teeth in wheel.
P' = linear pitch of worm.
D = throat diameter of wheel.
d = outside diameter of worm.
D' = pitch diameter of wheel.
d' = pitch diameter of worm.
a = pressure angle.
$E = \dfrac{D' + d'}{2}$ = center distance between the worm and the wheel.
S' = Effective height of worm tooth above pitch line (see Fig. 4).

An inspection of Fig. 4 will show that S' may be expressed as follows:

$$S' = \frac{D'\ (\text{Sin}\ a)^2}{2}.$$

If we limit the height of our tooth to this line, thus allowing no interference, we may use the following formulas, it being considered that we have given E, P', and N.

$$D' = \frac{N\,P'}{\pi} \qquad (1)$$

$$d' = 2\,E - D' \qquad (2)$$

$$d = d' + D'\ (\text{Sin}\ a)^2 \qquad (3)$$

$$D = D' + 1.273\ P' - D'\ (\text{Sin}\ a)^2 \qquad (4)$$

For a pressure angle of 14½ degrees and an allowed interference equal to that of a standard worm in mesh with a 25-tooth wheel, these last two formulas will become:

$$d = d' + \frac{D'}{13} \qquad (5)$$

$$D = 0.923\ D' + 1.273\ P' \qquad (6)$$

These formulas will give as much of the contact on the release as is possible without too much undercutting; the location of the pitch line will, of course, vary widely. Formulas 3 and 4 (when $a = 14\frac{1}{2}$ degrees) are good for any number up to 64 teeth, and formulas 5 and 6 up to 52 teeth. Above these numbers the formulas would bring the pitch line below the root diameter of the worm, which is needless; so for such cases, formulas 3, 4, 5, and 6 should be replaced by the following, which will keep the pitch line within the working area of the tooth.

$$d = d' - 1.273\ P' \qquad (7)$$

$$D = D' \qquad (8)$$

All that has been said in the preceding paragraphs refers only to worms whose tooth outlines show straight sides on an axial section. If, as is often the case with steep-pitched worms, the cutting tool is made with straight sides, but tipped up at an angle to agree with the helical angle of the worm, an axial section will show teeth with curved sides whose shape will depend upon the helical angle. In such a case as this it is impossible to apply any of the rules which govern the action of involute teeth, and the only way to go about the matter of locating the pitch line to suit the ideas of the designer is to make a careful analysis of the tooth action on various sections. This operation would be so troublesome and tiresome as to be impracticable under any ordinary circumstances.

TECHNICAL READING AND FORMULAS.—2.

C. F. BLAKE.

STRAINS AND STRENGTH OF MATERIALS.

Having mastered the written engineering language sufficiently to deal successfully with formulas, the next step is to make the acquaintance of such engineering terms as are most frequently met with. Foremost among these are the terms relating to the strength of materials.

If a bar is laid across two supports as in Fig. 4, and a weight placed in the center of it, we shall, if the bar be limber, witness the bending of the bar as shown, or as expressed in engineering terms, the deflection of the bar. It is obvious that the stiffer the bar, the less the deflection, and that a bar might be so lacking in stiffness as to actually break when the weight is placed upon it. Now the bar may lack stiffness from one of two causes; it may be that its dimensions are not well proportioned, or it may be made of soft and pliable materials. Sometimes both these causes are combined in the same bar

If the bar does not break when the weight is placed upon it we must admit three facts; first, that the weight bends the bar; second, that the bar resists the bending; third, that the bar is able to resist the bending because it is large enough and made of stiff enough material.

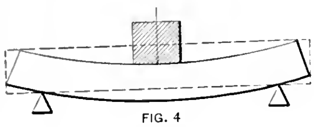


FIG. 4

FIG. 5

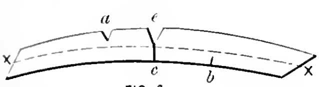


FIG. 6 Machinery,N.Y.

The bending effect that the weight has upon the bar is called the bending moment upon the bar due to the weight.

The ability of the bar to resist the bending is called the moment of resistance of the bar.

How these names first came into use the writer does not know, perhaps there is no explanation, but the reader must not confuse the terms with any period of time because of the word moment. Time has nothing whatever to do with the strength of the bar, or the effect of the load upon it.

In Fig. 4 the point at which the greatest bending occurs is directly under the weight, and we say the bending moment is maximum at this point, and the moment of resistance of the bar must equal the maximum bending moment at this point in the bar.

In using the term bending moment, the engineer usually means the maximum bending moment, because this is the greatest bending effect upon the bar, and we shall hereafter drop the word maximum.

If now we let M = the bending moment on the bar, and R = the moment of resistance of the bar, we can express the relation of the two as given above thus:

$$M = R. \qquad (4)$$

We said that the maximum bending moment was under the weight, and if the weight is placed further along on the bar, nearer one support than the other, the maximum bending moment will move with the weight. Also if the bar is differently supported the maximum bending moment will be at another point.

For all cases of frequent occurrence engineers have tables of formulas giving the position and amount of the maximum bending moment, so that it is only necessary to find in the tables the same case as the one we are considering, and taking the formula there given, substitute for the letters the corresponding dimensions in our case, and we have a numerical expression for the bending moment. The formulas given in these tables consist of combinations of dimensions measured along the bar, and weights of the loads on the bar. If when substituting values for letters in the formula, loads are taken in tons, and distances in feet, the bending moment will be expressed in foot-tons, while if loads are taken in pounds and distances in inches, the usual custom, the bending moment will be expressed in inch-pounds.

The following is a small portion of such a table as may be found in any book on machine design in any drafting room or factory, as well as in all the hand books issued by the steel mills.

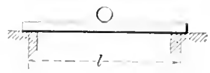
TABLE 3. BENDING MOMENT OF BEAMS UNDER VARIOUS SYSTEMS OF LOADING

W = total load.
l = length of beam in inches.
I = moment of inertia.
Z = section factor.

Case I.

Beam fixed at one end and loaded at the other.
Max. bending moment at point of support = $W\,l$.

Case II.



Beam supported at both ends. Single load in middle.
Max. bending moment at middle of beam $\dfrac{W\,l}{4}$.

Machinery,N.Y.

So much for the first member of our equation, the bending moment on the bar. We have already seen that the bar offers resistance to bending by reason of two things, its dimensions and the character of its material, and we should expect to find both dimensions and material accounted for in the formula for the moment of resistance of any bar. This is just what the formula for the moment of resistance does. It is composed of two parts or terms, one of which expresses the resisting effect of the material of the bar, and the other expressing the resisting effect possessed by the bar because of its shape and size. Let us investigate each term by itself, taking first the resisting effect of the material.

Let the reader take an ordinary rubber eraser of the form shown in Fig. 5, and bend it as shown in Fig. 6. While holding the eraser in the bent position, draw a sharp knife across the top side. The cut immediately spreads out in the form of a V as shown at a. Draw the knife a second time through the same cut and the V spreads a little more. Now draw the knife across the bottom. The cut immediately closes up as at b. Draw the knife a second time across the same cut and it will still close up completely. In making the second cut on this side it may be necessary to release the eraser from the bent position because the closing cut grips the knife blade and makes cutting difficult, but the cut will close, upon again bending the rubber.

Having made the two cuts a and b, reverse the bend in the eraser and witness the closing of cut a and the opening of cut b. Now if you are a careful experimenter, you can start two such cuts as a and b directly opposite each other, and by cutting each one the same amount each time, you can succeed in bringing them nearly together in the center as shown at c. Of course it will be impossible to bring them quite together because that would cut the eraser apart, but by a little care you can satisfy yourself of these facts; that the portion of the eraser above the center line $x\,x$ separates when cut; and that the portion below the line closes when cut. Reversing the bend of the eraser as before reverses the behavior of the cuts, but observe that whichever way the eraser is bent, the opening cuts are to be found on the convex side, and the closing cuts on the concave side.

We know that all material (engineering and building material at least) is composed of fibers, and we must conclude from the behavior of our eraser that all the fibers on the convex side of the line $x\,x$ are stretched when the eraser is bent, while the fibers on the concave side of $x\,x$ are compressed.

Since the cut through the stretched fibers opens like a V we may conclude that those fibers lying at the top of the V are stretched more before the cutting than those lying at the point of the V.

A careful examination of the cut made through the compressed fibers will show that at the outer portion of the cut, the edges are raised slightly, while at the inner portion near the center of the eraser, the edges are not raised. We can account for this only by assuming that the fibers at the outer portion are more compressed than those near the center of the eraser.

Having performed these experiments and noted the results, we must admit the following facts: 1st, that half the fibers of

a bent bar are in compression while the other half are stretched, or as engineers say, are in tension; 2nd, that the amount of compression or tension is greatest at the outer portion of the bar, and diminishes towards the center of the bar; 3rd, that it follows from this, as well as from experiments with cut c, that there must be a line through the center of the bar where the fibers are neither in compression nor tension.

Now the fibers resist any change in their condition, either stretching or compressing, the amount of resistance differing in different materials. Iron fibers resist more than rubber fibers for instance.

When a bar is bent, engineers speak of the fibers as being under stress, some being under compressive stress, and others under tensile stress, as we have seen, and they speak of the bar as being subjected to fiber stress.

Now fiber stress is expressed in pounds per square inch, and it is the duty of the engineer when designing a beam or other structure to keep the fiber stress within safe limits, and these safe limits are given in hand books for a great variety of materials, in tables of which the following is a sample.

TABLE 4. STRENGTH OF MATERIALS—POUNDS PER SQUARE INCH.

MATERIALS.	Ultimate Strength.	Safe Working Strength.	Factor of Safety.	Kind of Stress.
Cast Iron.	88,640	16,000	5	Compression
	15,620	3,000	5	Tension
Steel.	82,500	16,000	5	Compression
	80,000	16,000	5	Tension

Since the material composing the bar derives its ability to resist bending by reason of the resistance of its fibers to changes, the fiber stress must be one of the terms expressing the moment of resistance of the bar. The fiber stress is denoted by the symbol f.

The second term of the moment of resistance of the bar takes into consideration the strength the bar derives from its dimensions.

Bend the eraser in the direction of its greater thickness. We note it takes a much greater force to bend it thus than to bend it as we did at first in the direction of its least thickness.

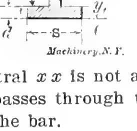
If we repeat the experiments with the cuts while bending the eraser thus, we shall find that everything witnessed before holds good for this case also.

If we look for a reason for the greater force required to bend the eraser in the direction of its greater thickness, we shall find it in the fact previously observed, that the fibers are more stretched or compressed the further they are from the center line $x\,x$, and thus they present greater resistance to bending.

The line $x\,x$ is called the neutral axis, because on it the fibers are neutral, being neither stretched nor compressed, and the fibers at the outer portion of the bar are called the extreme fibers, because they are furthest removed from the neutral axis $x\,x$.

The second term of the moment of resistance, taking account of the shape and size of the bar, is called the section factor, sometimes also called the section modulus, and is given in all hand books in the shape of tables for different shapes of beams, like the following sample.

TABLE 5. VALUES OF I (MOMENT OF INERTIA) AND Z (SECTION FACTOR) FOR VARIOUS SECTIONS.

	Section.	I	Z	Area.
Case I.		$\dfrac{b\,h^3}{12}$	$\dfrac{b\,h^2}{6}$	$b\,h$
Case II.		$\dfrac{b\,y_c^3 + B y_1^3 - (B-b)a^3}{3}$	$\dfrac{I}{y_1}$ $\dfrac{I}{y_c}$	$B\,d + b\,D$

The neutral $x\,x$ is not always in the center of the bar, but it always passes through the center of gravity of the cross section of the bar.

Here we shall have to digress for a moment, since in writing these papers it is the intention to leave no term unexplained. The reader may best become acquainted with the center of gravity in the following manner: Cut out of stiff cardboard the shape of the cross section of the bar, and balance it over a sharp edge, such as a triangular rule. Draw a line across the card corresponding to the edge over which it is balanced. Repeat the experiment, turning the card around on the edge, and balancing it a second time, draw another line. The intersection of these two lines will be the center of gravity of the section of the beam. If the experiment has been done with sufficient care, the card may be balanced upon a sharp point placed at the intersection of the two lines, just as if the entire material of the card were placed vertically above the point. A definition frequently met is: The center of gravity is that point at which the entire weight of a body may be considered as concentrated.

Another way of finding the center of gravity is to suspend the card by a fine thread alongside of a plumb line, and when the card and line have come to rest, mark the position of the plumb line on the card. Turn the card around and suspend a second time from a different point, and mark the position of the plumb line again. Where the two marks of the plumb line cross will be the center of gravity of the figure. No matter from how many points the card may be suspended, the plumb line will always be found to pass through the center of gravity. A line on the side of the beam directly opposite the center of gravity thus found will be the neutral axis. See Fig. 7.

If we now take the equation expressing the relation of the bending moment on the bar to the moment of resistance of the bar, and use the symbols for the two parts of the moment of resistance, we shall have

$$M = R = f\,Z.$$

Some tables do not give the section factors Z for all sections directly, but say it is $\dfrac{I}{y}$, and therefore we must understand this expression.

The denominator y of the fraction is the distance from the neutral axis $x\,x$ to the extreme fiber of the bar, see Fig. 8, and the numerator I is what is called by engineers the moment of inertia of the section of the bar. Here again there is a chance for confusion because of the use of the word inertia.

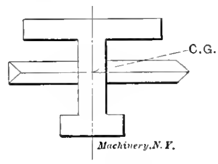


Fig. 7.

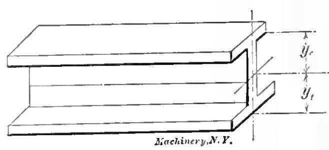


Fig. 8.

"The term moment of inertia was originally employed when comparing the energies of rotating bodies. We know that a moving body possesses energy due to that property of matter which engineers call inertia. Inertia is not a force; it is simply resistance, and is due to the incapability of a dead body to move, or of a moving body to change its velocity or direction without the application of some external force. Now the number of foot-pounds of energy possessed by a moving body is equal to $\frac{1}{2} M V^2$, where M is the mass of the body, and V its velocity in feet per second. A moving body then, must be acted upon by an external force before it can be brought to rest. A rotating body is simply a very large number of particles moving in circular paths about an axis called the axis of rotation. Each moving particle, therefore, possesses energy due to its inertia, and the energy of each particle is equal to $\frac{1}{2} m\,v$, where m is the mass of the particle, and v its velocity in feet per second. But the energy varies as $m\,v^2$, because simply dividing by 2 does not change the relative values. It is also obvious that the circumferential velocity of each particle varies as the distance from the axis of rotation, which distance or radius we call r. Hence, substituting r for v, the energy of each particle varies as $m\,r^2$. Suppose we imagine that the whole mass of the rotating piece, that is the sum of all the small particles m, is concentrated in a circle that is of

such diameter that the energy possessed by the entire mass is the same as before. The radius of this imaginary circle is called the radius of gyration, and is usually designated by the letter r. Now we may say that $M r^2$, where M stands for the whole mass, is a measure of the energy of the rotating piece. This expression $M r^2$ is given the name moment of inertia, each particle of which the rotating body is composed possessing a turning moment about the axis of rotation, due to its motion and inertia.

When it was discovered that the flexure of a beam depended upon the value $a r^2$ (where a is the area of the cross section of the bar, and r^2 is the mean of the squares of the distances of the infinite number of small areas into which the area of the section may be supposed to be divided, from the center of gravity of the section) $a r^2$ was seen to be similar to the expression $M r^2$, which in connection with the rotating bodies, had already become known as the moment of inertia; so, very carelessly on the part of those who first committed the error, it was said that the flexure of a beam varied as its moment of inertia, not because inertia has anything to do with it, for of course it has not, but because $a r^2$, the expression for the moment of resistance to flexure, happened to vary in the same way as the moment of inertia $M r^2$ of the same body when rotating about its center of gravity."

The moment of inertia of a bar may be calculated by several methods, but the tables give it for all usual shaped sections, and we will not attempt the calculation in these papers.

Since we are sometimes able to find in tables only the moment of inertia of a bar, and not the section factor, we must bring our formula one step further, thus:

$$M = R = f Z = f \frac{I}{y} \qquad (5)$$

or

$$Z = \frac{I}{y} = \frac{M}{f} \qquad (6)$$

and here we have the formula for determining the size required for any beam.

For beams in which the center of gravity is not in the center of the beam, there will be two values of y, one of which we will denote as y_c being the distance from the neutral axis to the extreme fibers in compression, and the others as y_t being the distance from the neutral axis to the extreme fibers in tension, see Fig. 8.

In some materials the ability of the fibers to resist tension is about equal to their ability to resist compression, while in other materials there may be great inequality in this direction, some being much stronger in tension than in compression, while others are stronger in compression than in tension. In such a material we shall have two values of f, which we will denote as f_c and f_t for compression and tension respectively.

Some tables on the strength of materials give what is called the ultimate or breaking strength of the materials, while other tables give the safe working strength of materials.

When using the latter tables, the values given are to be substituted directly for f_c and f_t in the formula. Since it would not do to have the material of which a beam is made strained up to the breaking point, we must, when using the former tables, make use of a factor of safety. This factor of safety is a divisor by which the breaking strength of a beam is divided to allow a margin of strength in the beam. This divisor varies from 2 to 10, and the proper use of different divisors is given in the text books.

To illustrate, the breaking strength of steel may be given as 80,000 pounds per square inch, and $\frac{80{,}000}{5} = 16{,}000$. If we substitute 16,000 for f in the formula, we shall be working our material with a factor of safety of 5, and the beam should not actually break until loaded with five times the load designed for. As a matter of fact, the beam would become badly bent long before five times the load could be placed upon it.

We have seen that all material deflects under the influence of a load, and we suppose that the elasticity of the material causes it to spring back to its original condition when the load is removed. This is true within limits, but there is a point somewhere between the safe load and the breaking load at which, when the load is gradually increased, the beam becomes strained beyond its power to return to its original condition upon the load being removed. This point is variously called the limit of elasticity, the yield point, the point of permanent set.

Let us now take up two examples illustrating the ground we have just passed over, and the use of the tables.

Example 1. A rectangular steel bar 2 inches thick is built into a wall as in Fig. 9, and is to hold a load of 3,000 pounds at its outer end, 36 inches from the wall. We wish to know the required depth to make the beam.

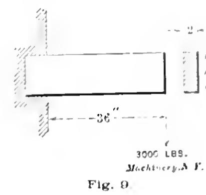


Fig. 9

1st, consider the bending moment on the beam. According to case 1, table 2, the bending moment is

$$M = W l.$$

For our case we know W and we know l, and substituting these for the letters in the formula gives us

$$M = 36 \times 3{,}000 = 108{,}000 \text{ inch-pounds.}$$

2d, consider the permissible fiber stress in the steel bar. Table 3 gives the safe working strength of steel as 16,000 pounds per square inch.

3d, using formula (6) we can find the value of the section factor for our beam. We know the bending moment and we know the fiber stress, so substituting these for the letters in the formula we get

$$Z = \frac{M}{f} = \frac{108{,}000}{16{,}000} = 6.75.$$

4th, find the section of our beam in table 4, case 1, where we find that the section factor is

$$Z = \frac{b\,h^2}{6}.$$

We know Z and we know b, so substituting these values for the letters, we get

$$6.75 = \frac{2 \times h^2}{6}.$$

If we multiply both sides of this equation by 6, we shall not change its value, but shall get

$$6 \times 6.75 = 2 \times h^2.$$

If we now divide both sides by 2, we shall not change its value, but shall get

$$\frac{6 \times 6.75}{2} = h^2 = 20.25$$

5th, we can most conveniently find the square root of 20.25 from a table of squares and roots which may be found in any hand book. This square root is 4.5, and we thus find that

$$h = 4.5 \text{ inches.}$$

If we make the beam 2 inches thick by 4.5 inches deep by 36 inches long, it will support a load of 3,000 pounds at its free end, and the fibers will be strained to 16,000 pounds per square inch.

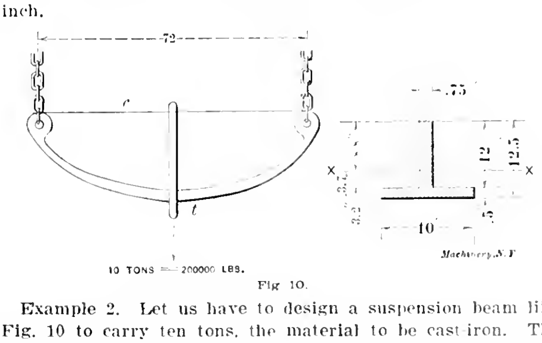


Fig. 10.

Example 2. Let us have to design a suspension beam like Fig. 10 to carry ten tons, the material to be cast iron. The proposed section of the beam is more complicated than that of the previous example, and we cannot obtain a result quite so directly.

1st, inspect the proposed beam to locate the compression and tension flanges. We find the compression flange is on top and

the tension flange on the bottom, and we mark them c and t respectively.

2d, table 3 shows us that cast-iron is stronger in compression than in tension, hence we conclude we should have more metal on the tension side than on the compression side, and accordingly we place the section with the heavy side down.

3d, assume a section by making the best guess possible as to the dimensions shown heavy in the figure. Cut this section out of cardboard, and find the location of the neutral axis $x\,x$ as previously explained. Now fill in the figures shown light by measuring the cardboard section.

4th, find the section in table 4. Here we find that before we can get the section factor of the beam we must get the moment of inertia of the beam. Substitute the dimensions of our section for the letters of the formula given in table 4, and we shall get

$$I = \frac{(.75 \times 8.8^3) + (10 \times 3.7^3) - (10 - .75)\,3.2^3}{3}$$

$$= \frac{511.1 + 506.5 - (9.25 \times 3.2^3)}{3}$$

$$= \frac{1017.6 - 303.12}{3} = \frac{714.48}{3} = 238$$

5th, now divide the moment of inertia just found by the distances of the extreme fibers from the neutral axis, that is, by y_c and y_t, and we get

$$Z_c = \frac{I}{y_c} = \frac{238}{8.8} = 27 \text{ section factor for compression side.}$$

$$Z_t = \frac{I}{y_t} = \frac{238}{3.7} = 64.3 \text{ section factor for tension side.}$$

6th, inspect table 2 and find the bending moment on the beam according to case 2, substituting the dimensions of the beam and the load to be carried in the formula given, we have

$$M = \frac{W\,l}{4} = \frac{20{,}000 \times 72}{4} = 360{,}000 \text{ inch-pounds.}$$

7th, dividing the bending moment just found by the section factors found in the 5th step, will give the fiber stress on the beam according to formula (6), thus

$$\frac{360{,}000}{27} = 13{,}333 \text{ pounds per square inch on the compression side,}$$

$$\frac{360{,}000}{64.3} = 5{,}600 \text{ pounds per square inch on the tension flange.}$$

The latter is too high, so another guess must be made, making the section heavier on the tension side. Then the steps 3, 4, 5 and 7 must be repeated, and if the fiber stress then comes below 3,000 pounds per square inch, the section will be right.

* * *

HOW A KNIFE-EDGE STRAIGHTEDGE WAS MADE.

F. N. GARDNER.

Except among gage and fine toolmakers the use and value of the knife-edge straightedge is not so well understood by the machinist trades as it should be. Many a workman who has just turned in a nice "fine-haired" job would be surprised to have an old-timer go over it with his "knife-edge" and show him hollows that "you could drive a hack under." The knife-edge certainly will show up imperfections, and likewise magnifies them.

Some twenty-five years ago, starting out on a manufacturing venture (Hartford Tool Co.), we took up among other things the building of knife-edge straightedges. So far as my information goes, this was the first attempt to put them on the market as a regular line. It was decided to put them out, three in a set 3, 4½ and 6 inches long, together, of course, with a test-bar, otherwise how could you tell whether they were any good or not. So far everything was easy, and it was up to me to "deliver the goods." I put in several solid weeks teaching myself how to make straightedges and test-bars, and at the end was able to turn out satisfactory sets at a reasonable cost.

The blanks were milled from annealed tool steel to about the section shown in Fig. 1. The hardening was done by dipping the edge ¼ inch deep in red-hot lead and plunging in water, back first. I do not recollect any difficulty from springing. They were tempered on hot sand to a light straw color. The only machine grinding, except polishing, was done on a very simple fixture in a universal grinder, as shown in Fig. 1. This gave a sharp edge of about 60 degrees angle which was approximately straight. They were then ready for hand lapping.

The test-bars were the next proposition. We tried many and various things with unvarying poor results; hardened tool steel, casehardened soft steel, chilled castings, hard bronze, etc. Some were too hard and expensive to work and all were unreliable when the weather changed. We finally settled on plate glass as the best available material. Plate glass about

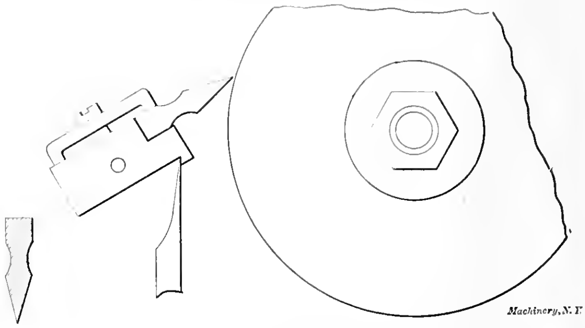


Fig. 1. Section of Blade and Method of Grinding.

5-16 inch thick was scratched with a diamond and broken into pieces 7 inches long by 1⅝ inches wide. These were ground at edges and ends reasonably square, straight and uniform in size on a grindstone by hand one at a time. The glass bars were then cemented together, with patternmakers' shellac varnish, into blocks of convenient size, say 4 or 5 by 7 inches. See Fig. 3.

The blocks, each one made up of 8 or 10 bars, were ground or lapped by hand on a cast iron plate 30 inches square with loose corundum. One side only of the blocks was thus ground down, as one true edge only was required on the finished bar. For this operation we started in with coarse grain, about No. 42, using finer grain as the grinding progressed, and completing the block lapping stage with about No. 80 or 90. The blocks were then soaked in water until they came apart, which they did very readily as only a small quantity of shellac was

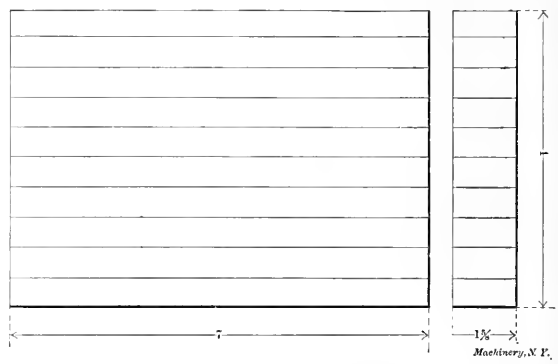


Fig. 2. A Block of Glass Straightedges.

used and that only in spots at the ends. The corners of the lapped edge were then beveled 1-32 inch all around on the lapping plate. They were then given a heavy coat of black asphaltum varnish all over except the finished edge. This seemed to completely absorb the light and made the finished edge look like vulcanized black rubber. The asphalt was covered with several thicknesses of manila paper, and then neatly bound with Russia leather, leaving the finished, or rather the to-be-finished, edge uncovered. The test bars were now ready for lapping. So far everything was comparatively easy, rapid and not very expensive. But right here I had to take up a course of manual training with myself for instructor. Re-

member it was not up to me to make one good straightedge only, but to turn them out by the hundreds at a cost price that would permit selling them at a profit.

No one would wish to follow me through all my mistakes and failures even if I could remember them, but I will try to describe some of the methods that led to such success as I attained and to indicate a few ways of "how not to do it," which are quite as necessary to understand and much more expensive to follow. I soon decided that the personal requirements were a clear eye, a steady hand and an amount of patience and perseverance that would make a Jap turn green with envy. For a lapping plate I used at first a block of fine soft cast iron 10 inches square by 3 inches thick, planed as nearly perfect as possible on the theory that if the lap was straight the work finished on it would be straight, but it didn't work out that way. It is difficult if not impossible to file a surface of any considerable size accurately straight and flat with a perfectly straight and flat file. I proved to my own dissatisfaction that it was equally difficult to lap a piece straight on a flat lap. My next move was to get a piece of cast iron 2 inches square by 12 inches long. This was accurately planed to the cross section shape shown at Fig. 4. This gave me four working sides, each of which I charged with different grades of corundum.

The method of charging this cast iron bar and the results obtained with it I consider to be the most essential features of my success. The only abrasive I used for the finish lapping was flour corundum separated by washing into four different grades. The washing method of getting abrasives down fine is so well-known that I don't need to describe it here. To charge the bar, Fig. 4, I sprinkled the flour corundum, of whichever grade I wished to use, quite liberally on the 10-inch square iron plate, laid the bar on it and rubbed it in. After a few treatments the section of the bar changed to the shape shown in Fig. 5 only not so much, of course, as shown in the exaggerated cut. The tendency was for the bar to be rounding (convex) and the plate to be hollowing (concave). Remember I am talking about small measurements—probably the difference between the highest and lowest point of the surface of the bar anywhere would not exceed five ten-thousandths of an inch, but half a thousandth of an inch opening lets a big chunk of light through under a knife-edge. When the bar was lapped until all its working surfaces were slightly rounding (convex), it was also thoroughly charged with corundum grains bedded into the metal. All loose grains had to be carefully dusted off—nothing is more destructive to your last touch of accuracy and finish than loose grains of abrasive skating around on the lap.

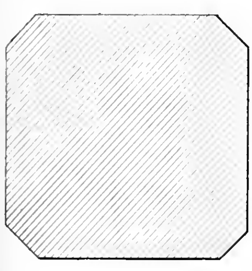


Fig. 3.

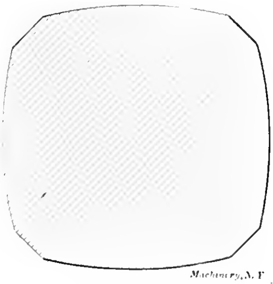


Fig. 4.

I now had my tools working all right, and by that time I had learned a good deal about using them. The straightedges as they came from the grinder had a sharp wire-edge. This edge was then rounded to about 5-1,000 to 8-1,000 inch radius (free hand work and eye measurements) with an oil-stone. They were then ready to be made straight.

By days of solid labor I had acquired a "test bar" as I called it. I was as familiar with its imperfections and vagaries as a barber is with his razor. I knew its straight places and its big hollows and its little hollows, how it would act when the thermometer stood at 95 and how when it stood at 60 deg. It was made of chilled white iron. I always used it when finishing straightedges in preference to the nearly perfect glass test-bars that I was afterwards able to make. I found that its very imperfections, *i. e.*, the big and little hollows, were a help in detecting and locating the imperfections on the straightedges. The method of testing was to slide the straightedge lengthwise on the test-bar. If the hollows in the bar showed just the same under all parts of the edge, it was good evidence that the edge was straight. Of course both were held between the eye and a strong light. Light under these conditions, when it can be seen at all, seems to be greatly magnified and I always thought that I could detect a smaller imperfection in the straightedge with my old humpy iron test-bar than I could with the much more perfect glass ones.

After days many and full of trouble, I discovered something, a very simple thing, one that a person possessed of common sense ought to have known without being told. As hollows cannot be raised by lapping, I went at the high spots, but strange to say the more I rubbed the higher they seemed to grow. I thought to myself—"lap don't cut—needs charging." I take five minutes charging the lap and fifteen more starting a man on a job, come back, pick up the same piece and find a big hollow where the high spot was. The explanation was simple. The friction of lapping generated enough heat to expand the piece faster than I ground it off, and when it came back to an even temperature it showed that I had taken off too much. I suppose that the reason why I did not find out this point sooner and why others have been fooled in the same way is that I used great care *not* to heat the pieces by friction, using a slow motion and light pressure, and could not feel any heat with my fingers. At first I thought the pieces were changing and springing on their own hook—or call it "molecular adjustment"—and would finally get settled down and keep quiet. I finally got down to this procedure:

I would pick up a piece, if a straightedge would try it on the test-bar, locate the highest high spots, give them a few *swift* rubs on the rounding lap right in the place where it would do the most good, and without a second look lay it down at the back of the pile to cool off. Say there were 100 pieces in the pile, or row; in this way I went straight through the row from the 1st to the 100th and then over and over again. The high spots get lower and the hollows begin to disappear, and I to lap slower and lighter. Near the finish I used a wooden holder on the straightedges to keep the heat of my fingers away from them; some sort of a non-conducting holder should always be used on the longer straightedges—the glass test bars are sufficiently protected by their binding.

The final test, and I think it was a very severe one, was to place a fiber of cotton across one end of the test-bar, rest the point of a 6-inch straightedge on the fiber and let the back end touch the bar. If both bar and edge were accurate they would show a gradually diminishing streak of light from the fiber to within less than 1 inch of the back end of the straightedge. I was not able to measure this fiber of cotton very accurately with an ordinary micrometer, but I concluded that they averaged about 1-10,000 inch diameter. If this is approximately correct, I think we were not far off, in our catalogue statement that light could be seen through an opening 1-50,000 inch between a knife-edge straightedge and a test-bar. This statement was afterwards disputed by a correspondent in a mechanical paper and I believe has been withdrawn from the catalogue of our successors in the business. It would be interesting, to me at least, to get the opinion of men who know on this point.

To anyone who wishes to make knife-edge straightedges or knife-edge square blades and test-bars, I will offer the following suggestions:

Use carborundum on the lap—it is better than corundum. I do not know of anything better for the lap than fine-grained soft cast iron. They do not need to be so large as the sizes I have given, much smaller pieces will answer for home-made work. Keep the surface of your bar lap slightly rounding (convex). Do not rub your work on the charging plate, but only on bar lap, and do not rub lengthwise, *i. e.*, from end to end, but hold it at an angle with the bar, say from nearly straight to square across, and be very careful to touch nothing but the high spots. There is no law against using a slip Arkansas stone on the bad high spots in the straightedge, but

if you do you must be careful. The straightedge ought to be correct when leaning anywhere to 15 degrees either way as well as when straight up and down. You will find it comparatively easy to make it shut light if held in exactly the right position, but to give it an eighth of a turn either way and still have it shut light is not so easy. Do not start out with the idea that you can work steadily on a straightedge or test-bar until it is finished. My experience is it cannot be done, but that you can do only a very little work on each piece at a time, and the nearer you get to perfection the less you can do at each handling. Make up your mind to take anywhere from a month to a year to finish a set. If you have patience and sharp eyes and learn by experience as you go along, you will have put in twenty or thirty hours' time of actual labor and have a set of tools that you will be proud of, and one that it would take a lot of love or a good bunch of money to buy.

Closing a reminiscence will say that I exhibited one of our first commercial sets to the Brown & Sharpe Mfg. Co. in their office at Providence. After examining them very carefully with Mr. Viall, Mr. Sharp turned to me and said, "We have only one fault to find with these tools—your price is altogether too low." It did not take us very long to find out that there was "much of wisdom" in this remark.

* * *

CONDENSING PLANTS FOR HIGH VACUUMS—2.

In the March, 1906, number of MACHINERY was a description of one of the 500-kilowatt Curtis turbine units of the Newport, R. I., station, which was one of the first of these machines installed. This turbine was equipped with a Wheeler condenser and an Edwards air pump made by the Wheeler Condenser and Engineering Co., New York, and the construction of this pump is such as to make possible a simple arrangement of the condensing apparatus.

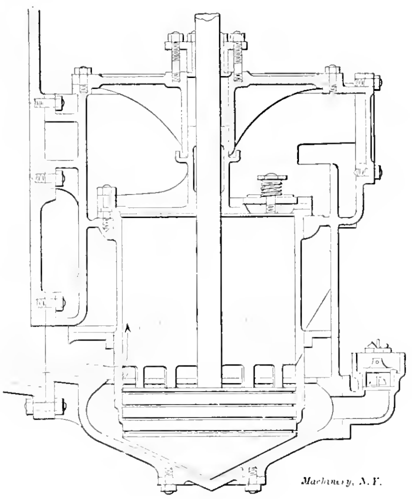


Fig. 6. The Edwards Air Pump.

Fig. 6 is a section of the pump cylinder. It is constructed without foot valves, which require a pressure in the condenser sufficiently above that in the pump to lift the valves, and overcome the inertia of the water. The condensed steam flows continuously by gravity from the condenser into the base of the pump, and is there dealt with mechanically by the conical bucket working in connection with a base of similar shape. Upon the descent of the bucket, the water is projected at a high velocity, through the ports, into the working barrel. The plunger then rises, closing the ports, and sweeps the air and water before it, causing them to escape through the valve at the top of the barrel. The elimination of the foot valves in this pump enables it to maintain a slightly higher vacuum than with the old-style pump, so that 27 or 28 inches can be maintained without the use of an auxiliary air pump.

Fig. 7 is a plan view of this turbine, condenser and pumps, and shows this to be about the most compact arrangement that can be had if a separate surface condenser is employed. By way of contrast we have, in Fig. 8, the lay-out of the apparatus shown in Fig. 3 of the last number. The condenser is located in the base of the turbine and does not appear in Fig. 8, but the auxiliaries are so disposed that the total floor space occupied is considerable.

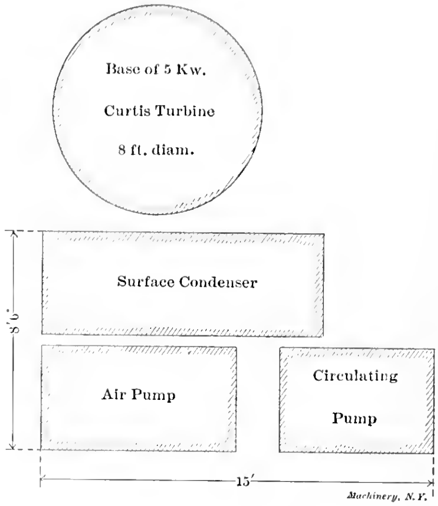


Fig. 7. Floor Plan of Newport Installation.

A novel arrangement for maintaining a high vacuum is the "vacuum augmenter" employed by Parsons with considerable success in England. He uses air pumps, as shown in Fig. 9, placed below the level of the condenser and in addition to the usual pipe connection between the air pumps and the condenser, there is a small pipe leading to an auxiliary condenser, generally having about one-twentieth the cooling surface of the main condenser. In a contracted portion of this auxiliary pipe is a steam nozzle which discharges a jet of steam that acts similarly to the jet of an injector. This jet draws nearly all residual air and vapor from the condenser, and delivers it to the air pumps. The main pipe leading to the air pump is so curved as to form an air seal which prevents the air and vapor returning to the condenser. With this arrangement there need be a vacuum in the air pumps of only about 26 inches, while the vacuum augmentor will increase the vacuum in the condenser to 27 or 28 inches. Mr. Parsons states that the quantity of steam required for this

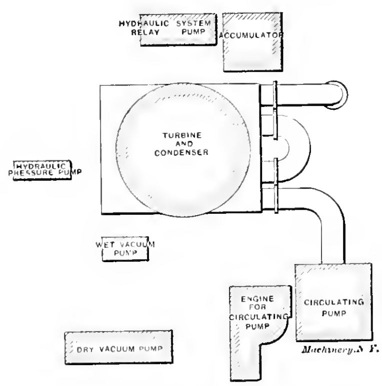


Fig. 8. Floor Plan of Unit shown in Fig. 3, October Issue.

steam jet is about $1\frac{1}{2}$ per cent of that used by the turbine at full load, and this, together with the air extracted, is cooled by the auxiliary condenser.

Jet and Injector Condensers.

The surface condenser has come into extensive use with the steam turbine because the steam discharging from a turbine is entirely free from oil and if collected and condensed can be used over and over in the boilers. The feed water leaves the hot well of a surface condenser operating at high vacuum

at nearly 100 degrees F., and passes through a heater where the temperature is raised still further by steam from the auxiliaries. In jet and injector condensers the condensed steam passes off with the injection water, which is at a temperature of 80 or 90 degrees, and when part of this is used for boiler feed there is a loss of some 10 or 20 heat units per pound, as compared with the surface condenser. This is so slight, however, that it does not pay to install a surface condenser and attending apparatus on the score of heat saved. The jet type is cheaper, simpler and works as well or better.

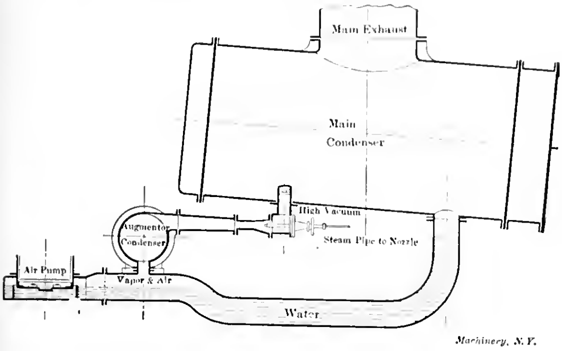


Fig. 9. Parsons' "Vacuum Augmenter."

In localities where the available water supply contains sulphate of lime, acid, grease, or other harmful impurities, or where the cost of pure water is high, the surface condenser should probably be given the preference, though if it is merely the cost of the water that is at stake, the problem should be gone into very carefully before deciding.

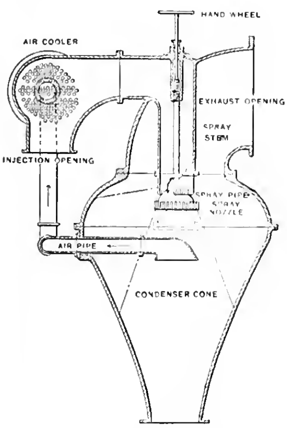


Fig. 10. Worthington Jet Condenser.

The only "out" about the operation of the jet or injector condenser at high vacuum is that more or less air is entrained with the injection water and unless this be removed it is difficult to maintain the vacuum. This can be done, however, by the use of a dry vacuum pump and an air cooler.

In a paper before the American Society of Mechanical Engineers in December, 1904, George I. Rockwood describes the installation of a Bulkley injector condenser in connection with a Westinghouse-Parsons turbine. The injection water is elevated into a vertical tank 30 inches square by 15 feet deep, in which the water level is maintained 6 inches below the water inlet nozzle of the condenser. The injection pipe takes the water from near the bottom of the tank. The air entrained with the water rises to the top of the tank and is largely eliminated from the injection water entering the condenser The flow of the injection water through the throat of the condenser is what constitutes the air pump, and it is found to be the only air pump needed, since a vacuum of 28½ inches has been maintained, regardless of whether steam is passing through the turbine or not.

A jet condenser, which is a modification of the injector condenser, is made by the Worthington company. As in the injector type, the condenser proper is placed about 30 feet above the hot well and the water falling, through the action of gravity, creates the vacuum. There is no contracted throat to this condenser, however, and the water is sprayed into the head, where it becomes intimately mingled with the steam before discharging through the vertical pipe. Fig. 10 shows a section of the condenser head. An air cooler and a dry vacuum pump are employed, such as used with surface condensers, and any air that accumulates in the condenser head, where the steam is condensed by the spray of the water, is removed by the pump.

An interesting application of a jet condenser to a Parsons turbine is shown in Fig. 11.* The novelty of the scheme consists in substituting a centrifugal pump for the usual barometric column, enabling the condenser to be placed under the turbine. The exhaust steam is led through a pipe, *A*, and a gate valve, *B*, into the condensing chamber, *C*; and there, it is condensed by a jet and flows into the opening of a centrifugal pump, which is driven by a belt from the pulley on the extended shaft of the turbine.

There is a check, *D*, in the discharge from the pump, and this discharge is also sealed by the outgoing water. At the top of the condensing chamber is attached the usual dry air pump connection.

The turbine is started as follows: Valve *B* is closed and the turbine is allowed to exhaust into the atmosphere by the automatic exhaust valve, *E*. At the same time the dry air pump produces a vacuum in the chamber which induces a flow of water. When the turbine is up to speed the pump is going with sufficient velocity to keep the condensing chamber clear and the valve, *B*, which for convenience is motor-driven, is opened, the free exhaust valve, *E*, promptly closed, and the turbine is running condensing. During the winter months this plant gave a vacuum of from 27½ to 29 inches and the cost was only one-third the cost of a surface condensing plant

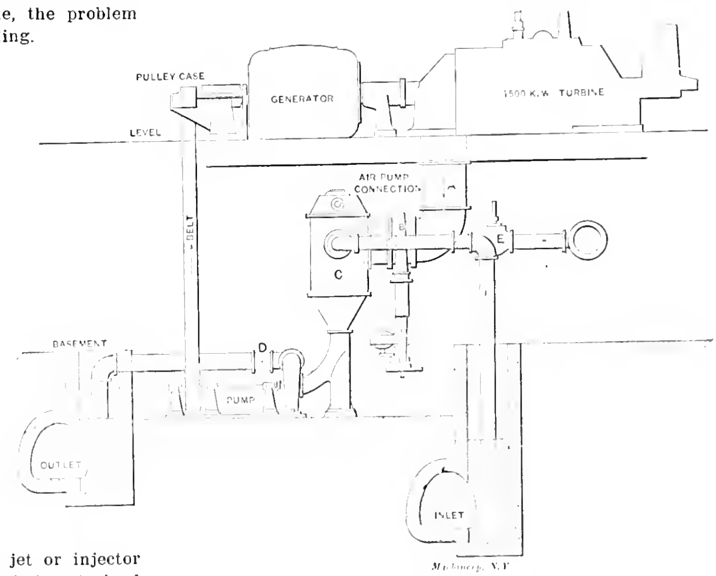


Fig. 11. Arrangement of Jet Condenser with Centrifugal Pump.

* * *

It is an interesting fact that the limitation of the speed of sewing machines, especially on thick goods, is not caused by the inertia of the reciprocating parts so much as by the heating of the needle. An ordinary steel needle will become so hot, working, say, at 3,000 stitches per minute, that it will turn blue and the temper will be drawn so as to make it useless. Strange to say, nickel-plating sewing machine needles reduces heating effect and considerably increases the speed with which cloth can be sewn. With the best modern lock-stitching machines, it is possible to sew at the rate of 3,000 or even 3,600 stitches per minute, using nickel-plated needles.

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MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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PAID CIRCULATION FOR OCTOBER, 1905,—22,066 COPIES.
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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

The statement of paid circulation in the above paragraph for the October issue should read: "Paid circulation for *September*, 1905—22,397 copies," instead of August as it erroneously appeared.

* * *

CONCENTRATING POWER TO REDUCE SMOKE

It is announced that Pittsburg is to be smokeless—smokeless for Pittsburg, that is—through the enterprise and foresight of George Westinghouse and H. C. Frick. Two immense power plants are projected, to be located outside the city limits, from which power is to be distributed to Pittsburg and other nearby cities or towns. About 3,000 acres of coal land have been purchased, and instead of shipping the coal to Pittsburg and burning it in the furnaces of the various factories and large buildings, the coal will be burned at the mines and power transmitted to Pittsburg.

While such an enterprise is a step in the right direction, it is to be doubted whether it will ameliorate to any considerable extent the almost intolerable conditions that exist most of the time in the "smoky city." This would depend somewhat on the number of power users that could be induced to purchase power from the new company. It would not diminish the smoke pouring from the stacks of the great steel works, situated up the Monongahela valley, which the wind sweeps down to the city in great black clouds, and, together with the fog from the rivers, extends the darkness of the night into the late morning hours.

The proposition to establish a plant at the coal mines and transmit power to points where it is to be used is an old one, and has been talked of for many years as a means of making use of the immense culm heaps at Scranton and other mining centers. There may eventually be many such plants established, and when the time arrives, which geologists tell is not very distant, that anthracite coal is a luxury and we all have to burn bituminous coal, it may prove that the soft coal nuisance is not so bad a nuisance after all, because heating, lighting, and power may then all be accomplished through electrical transmission from central stations. In such stations combustion of fuel can be regulated so that the smoke is not very objectionable; and the stations can be located where such smoke as does come from their chimneys will not reach the thickly populated sections. Some coal, however, will always have to be burned on the spot where the heat or power is required and the territory now served by the anthracite mines is destined some time to become a soft coal district.

* * *

WHAT IS UNSKILLED LABOR?

One of the contributors of MACHINERY, H. L. Millar, Manchester, England, has written us a little note protesting against the word "unskilled" labor. He very properly insists that there is no such thing in industry as unskilled work. Every effort that requires training, however small, to accomplish productive results is necessarily skilled; and the difference between it and so-called skilled labor is only one of degree. He suggests that there should be some other term used as a substitute for "unskilled," since that distinction is erroneous. The point is well taken, and we have often pondered on the subject for the question has frequently arisen with us as to what skilled labor really is. The ability to cook an appetizing dinner and to serve it in good shape requires manual ability and judgment of a high order; yet it is not usual to speak of domestic labor as being skilled. On the other hand, it is commonly thought of a watchmaker that he is highly skilled in the use of tools; although he may be a very awkward person with any other tools but those pertaining to his trade, and the chances are that he is. A farm laborer usually has a knowledge of the use of tools and an understanding of machinery that will put to shame many artisans who regard him and his calling with contempt. In short, a good laborer must generally have trained all muscles of his body and his sense of perception in such a way that he is competent to handle almost any job that may come his way. But the skilled artisan has generally trained only one set of muscles and perceptive faculties, and is consequently a very one-sided sort of person, both muscularly and mentally.

* * *

"HEROIC METHODS OF DOING WORK."

One of our correspondents finds fault with the heroic method employed in fitting the valve in the case of the hydraulic press repair described in the August issue. In a veiled way he gives the editor a jab for commending the "get-there" mechanic who sometimes uses means that are not sanctioned by the generally-accepted methods of the chaft. We think that our correspondent has attached too much importance to the editorial note on the subject, or has gotten a wrong idea from reading same. It was by no means our intention to commend lax or butchering methods of doing mechanical work. On the other hand, no one has a higher appreciation of what nice work is and of methods that must be followed to accomplish same. The point made in the editorial, or the one we intended to make, was that in time of stress the able foreman or superintendent is the one who can "cut corners" and "wrest victory from the jaws of defeat." In other words, he must take chances and do things that his better judgment would not commend when following the ordinary routine. It might be likened to the man who jumps from the dock to the steamer when the gang-plank is drawn in; if he reaches the deck safely, he is able to go on his trip and fulfill his engagement; and if he misses it he gets a briny bath—and perhaps worse. And in general, it is the man who takes chances that succeeds in the larger affairs of life. The successful merchant, financier, manufacturer and politician is the man who sometimes takes a "long chance"—and wins out. when he does so it is usually because it is either taking the chance or being defeated. He might as well be defeated in one way as another, but by doing a certain stunt there is the possibility of securing that which he desires.

* * *

The *Patternmaker* for October makes its appearance in a new form, as *Wood Craft*. The paper has been enlarged to the so-called standard size, 9 x 12 inches, and its scope has also been enlarged to embrace woodworking. The first issue is a creditable undertaking, and contains much that should be of interest to the craft in general. The leading article is an illustrated description of the woodworking department of the Eastman Kodak Company at Kodak Park, near Rochester, N. Y. Robert I. Clegg is the editor of the new paper; the publishers are the Gardner Publishing Co., Caxton Building, Cleveland, Ohio.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

New Orleans is now said to be the largest sulphur exporting port in the world, the product being obtained from beds in Calcasieu Parish, where a sulphur strata 700 feet in depth exists. Nearly 15,000,000 pounds of sulphur of 99.5 purity have been exported from this port for the first nine months of 1905. So pure is the sulphur that the custom authorities of France class it as a refined product, notwithstanding the fact that it has been through no refining process whatever.

It is rather difficult for a person inexperienced in the matter of low temperatures to realize that fine gun oil may congeal to such an extent as to render a firearm useless in time of emergency. A recent issue of *Graphite* quotes from a sporting paper, which states that at a temperature of 72 degrees below zero a hunter found that the oil on the lock and firing-pin was frozen solid and it was impossible to fire the weapon. The use of graphite did away with this difficulty, as it made no difference how cold the weather was, the lubricant was not affected. It is worthy of note in this connection, that at exceedingly low temperatures some of the smokeless powders are greatly deteriorated, and in some cases refuse to explode at all.

Consul General Guenther, of Frankfort, Germany, refers to the Cowper-Coles process of galvanizing, which has been mentioned several times before in these columns. An interesting statement was made regarding the galvanizing of copper by the Cowper-Coles process, which is that a copper rod can almost be entirely transformed into brass, while the temperature employed remains far below the melting point of both metals. The possibilities of the process are somewhat startling as this would seem to indicate that it may be possible to manufacture brass wire and rods directly from drawn copper without the intervention of the brass founder. An advantage of this process which has previously been alluded to is the evenness of the coating, it being so perfect in this respect that galvanized screws may be made to fit their nuts perfectly while ordinarily when galvanized they have to be recut or loosely fitted.

The limitation to the use of the ordinary projecting lantern such as is used for throwing pictures on a screen, is that all the slides must be transparent. A new lantern has been developed of the reflecting type which makes it possible to throw a greatly enlarged view of any subject upon a screen in its natural colors without previous preparation. Its value for the purpose of illustrated lectures can scarcely be over-estimated, especially in the case of biological work. In the case of lectures on mechanical subjects, it can be made to have a living interest that is impossible with the ordinary lantern. The works of a watch for example can be thrown upon the screen at almost any desired magnification while in motion, and the separate parts may be shown in a dissected state for the purpose of explanation. In the case of metallurgy it might be possible to throw a highly magnified view of metal specimens on the screen and in this way get the true effect that is largely lost when resorting to photographic views, especially when made on a transparent plate.

At the recent general meeting of the Association of German Engineers, held at Magdeburg, Dr. Eichberg, of Berlin, presented a paper dealing with the recent progress and future of electric train haulage. In the course of his observations the author stated that the Prussian railway ministry had come to the conclusion that, from an electro-technical point of view, neither the double overhead conductor nor the third-rail was suitable for the working of trains on large railway networks. A technically satisfactory solution, as had been clearly proved by the experiments at Spindlersfeld, near Berlin, was afforded only by the combination of a single aerial wire with high-pressure current and single-phase motor. The same system had been employed with success in the Stubbai Valley, Innsbruck. It practically presented no material difficulties. A pressure of 5,000 volts to 6,000 volts has been used on the Spindlersfeld line, and it would be possible to employ a pressure as high as 15,000 volts on mountain railways. It was intended to work the line at a pressure of 6,000 volts, the trains to be composed of motor cars and trailers in accordance with the traffic requirements. The proposal to build a high-speed electric railway between Dusseldorf and Cologne now forms the subject of negotiations between the local authorities of the two towns, with special reference to the discussion which has taken place with representatives of the Allgemeine Electricity Co. and the Siemens-Schuckert Works Co.

I remember a bicycle shop, says a writer in *Cycle Trader*, where a great many frames were built and where consequently a great deal of filing-up was done. The filing-up was done at piecework rates, and it was, of course, natural that the men on this particular job should try to get through as many frames in a day as possible. Naturally, also, they would get as many new files as they could, and equally naturally the manager would see that all files were worn out before being replaced with new ones. Each man, when started, was given a full set of files, and when he required a new one, the old one, either worn out or broken, had to be delivered into the stores before the new files were sent out. The storekeeper, after seeing that the files returned were really unfit for use, issued new ones and threw the old ones on the scrap-heap. Now, the scrap-heap was the common rubbish heap of the shop, to which all had access. What was more natural than that, when a man wanted a new file so as to cut quicker and get through more work, even if his old file was not nearly used out, he should go to the scrap-heap, select the oldest file of the class he wanted, throw away his half-used file and stalk up to the stores with the old file, which had probably done the same duty hundreds of times before, and return with a new file. And so things went on. The storekeeper only gave new files out against absolutely worthless ones, which he threw on the scrap-heap; the men always had new files when they wanted them, and everyone was contented. The scrap-heap collected quite a little stock of half-used files, the men made good piecework wages, and the proprietor paid for about twice as many files per week as were needed.

The development of the electrical industry has made a great demand for pure copper, inasmuch as a small percentage of impurity in copper considerably increases its resistance. The most practical way of producing pure copper is to deposit it by electrolysis on the cathode plate, but there are practical difficulties in making copper products by electro-deposition, especially copper wire, which, of course, is much in demand.

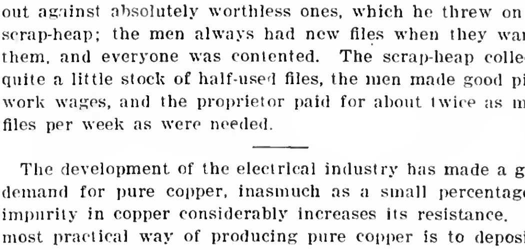


Fig. 1. Fig. 2.

At the July meeting of the Faraday Society, Mr. Sherard Cowper-Coles read a paper describing his development of the centrifugal process of electro-deposition. He is able to produce copper wire at a cost of from \$50.00 to \$75.00 per ton less than by the usual methods. The cathode is made in the shape of a huge mandrel about six feet in length and seven feet in diameter. It is mounted with the axis vertical and is rotated in the copper plating bath at peripheral speed of about 1,000 feet per minute. In this way the rough "tree" or nodular growth,

which is a troublesome feature of electrolytic deposition ordinarily, is avoided; but the novelty of the improved process lies in the shape of the mandrel surface, and its effect on the copper plating deposited. A V-shaped spiral groove is cut in the periphery of the mandrel from one end to the other. Now when the copper is deposited on this cathode, the V-shaped groove causes cleavage planes to be formed in the metal as shown in Fig. 1. When the required thickness has been deposited, it is possible to strip the metal off in a continuous wire, having the approximate section shown in Fig. 2. With a mandrel of the diameter mentioned having the V-groove cut with a lead of 1-16 inch, nearly 5 miles of the strip will be deposited, and of course a greater length of wire, the length depending upon the reduction in diameter in the drawing dies.

BRITISH IMPROVEMENT IN HAND REAMERS.

Hand reamers of the fluted type as ordinarily constructed, says the *Mechanical Engineer*, are liable to act irregularly, and so cause the surface of the hole to be uneven. To overcome this difficulty, Chatwin & Slater, of Birmingham, have designed and patented the design shown in Figs. 1 and 2. As will be seen, the reamer increases in diameter, from the point or lower end which first enters the work, by a series of steps or shoulders, as *C D E*, the cutting portions being the narrow steps or shoulders themselves, while the portions between the steps or shoulders are made parallel, or nearly so, and serve only as guides for the cutting edges. The parallel portions have no cutting action. The number of steps or shoulders varies according to the amount of metal to be removed from

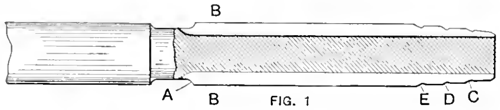


FIG. 1

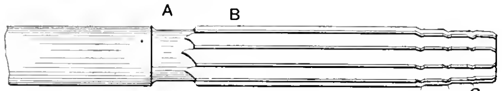


FIG. 2

the aperture or hole. The portions of the teeth, *B*, between any pair of the shoulders, such as the portions between *C* and *D* or *D* and *E*, are all ground practically parallel. The portions between *C* and *D* are ground to a diameter slightly less than the diameter of *D*, while the portions between *D* and *E* are ground to a diameter slightly less than that of the shoulder *E*. The portion between the first shoulder, *C*, and the bottom extremity of the reamer is ground to a diameter slightly less than that of the cutting edge formed at the shoulder, *C*, and it is made to taper down slightly toward its extremity. The reamer thus comprises a step-like series of cutting shoulders of progressive diameters with guiding and steadying surfaces between the steps, and with this arrangement the inventors have secured very effective and satisfactory results. Also the reamers may be readily sharpened by grinding the cutting shoulders without losing their size.

RAILWAY RATES IN ENGLAND.

Consul Mahin, Nottingham, Eng., in Consular Report No. 2378.

Regular passenger fares on British railways are not absolutely uniform on all roads for similar distances. First-class fare ranges from 3 to 4 cents a mile, second-class is about 2½ cents, and third-class about 2 cents. Distance cuts little figure in the rates except where several lines compete for business between two important points—London and Liverpool, for instance—when the longer routes make their fares the same as those of the shorter route. First-class accommodations are better than those of the ordinary American day coaches, but hardly equal to those of our drawing-room or parlor cars. The first-class compartment is more expensively upholstered and more roomy than the second and third class. Usually it is arranged to seat only six persons; the other classes eight. The first-class is comparatively little used, and then chiefly by persons who want seclusion or who ride on passes or season tickets. The familiar remark that only royalty and Americans travel first-class in England is hardly pertinent now. My own observation is that Americans generally ride second or third-class. Both are sufficiently comfortable, and are seldom crowded, long trains being uniformly run, and Americans (excepting the uninitiated on their first visit) generally consider it a mere waste of money to buy first-class tickets.

The second and third-class compartments are both upholstered, contrary to the continental system, where third-class means a plain wooden seat. The casual glance sees no difference between the British second and third-class, but the second has a better quality of upholstering. Some of the railways have, however, dropped out the second-class, and use only first and third, the second being so little used. None of the railways traversing this consular district provide the second-class. Nearly everybody rides third-class. It is essentially as good as an ordinary American day coach, and therefore the fare of about two cents a mile is lower than the usual fare in the United States.

But the multiplicity of special excursion and week-end rates makes it possible to travel almost anywhere, at almost any time, for a fraction of the regular fare. These low rates usually apply to only the third-class, in this locality, but sometimes are extended to the first, when one may travel first-class at less than ordinary third-class fare—that is, for less than two cents a mile in a compartment nearly equal to the American Pullman or parlor car. For instance, the regular fare from Nottingham to Skegness, a seaside resort 73 miles distant, is $2.37 first-class and $1.50 third, one way. Round trip week-end (from Friday to Tuesday) tickets costs $1.94 first-class and $1.21 third, or one and one-third cents a mile first-class.

Every week one or more special attractions in London give occasion to offer low excursion rates, and in addition, every Saturday round trip reduced rates are given on one-half day up to six-day tickets. The regular third-class fare from Nottingham to London, 125 miles, is $2.49. The special round trip fares are $1.03 for half a day, $1.82 for one day, $2.31 for two days, $2.67 for five or six days, and $3.40 for eight days. Only the half-day tickets are limited to special excursion trains. The others are good on ordinary trains. Most local people who can arrange to return within the time limit go to London on these tickets. As would naturally be expected, people who do not intend to return often buy day or half-day tickets because they are cheaper than the regular one-way fare, and sell or give away the return coupon in London; but in spite of this the railways evidently find advantage in continuing such rates.

Similar reduced fares are constantly being given to both near-by stations and distant points on the islands, and for the round trip are less or little more, depending on limit of ticket, than the regular fare one way. In short, if the traveler can suit his convenience to the particular days of the week when reduced rates are given, and to the trains, of which there is often a choice of several, he need never pay more than half the schedule passenger tariff on English railways. The acme of cheap traveling in this country was reached this summer. Once or twice each week railroads give excursion rates from London and provincial towns to seaside resorts which range from five to nine miles for a penny (two cents). These are not on slow way trains, made up of obsolete cars, but on fast "expresses," some being non-stop and composed of new corridor cars. Taking account of all these reduced fares, it is probable that English railway travel is the cheapest in Europe; and, withal, the English railways and their service are inferior to none.

PATENTS IN JAPAN.

British Trade Journal.

There have been many cases of Japanese imitations of foreign inventions not patented in Japan, and in the industrial awakening, which may soon be expected in Japan, such instances are likely to increase in number rather than decrease. When such time comes, those who have been lax about taking out Japanese patents in the past may discover that their goods cannot be patented, because they have been introduced and offered for sale and have thus become "publicly known" in a way that deprives them of the right of patent.

The following notes on Japanese patent law will be of service to inventors who may desire to have their inventions patented in Japan. The Japanese Patent Office is the Patent Bureau of the Department of Agriculture and Commerce. According to an Imperial Ordinance, No. 234, dated December 4, 1903, the bureau is organized with one director-general, four secretaries, four technical officials, 15 examiners, 20 assistant examiners, 10 clerks, and three draftsmen. The supreme court judges patent suits only in cases mentioned in Article XXXV. of the Patent Law of Japan. This law, like that of the United States, is based on the examination system, and only those applications are entertained that are found to be patentable under the examination of patent officers.

There are three ordinary stages of examination, first and second examinations and trial. Those who may not be satisfied with the denial of a patent in the first examination can apply for a second examination within the 60 days, counting from the date when the notice of the denial was received. In case of denial in the second examination, a similar remedy is allowed for trial, which is the last resort in ordinary cases. The term for which a patent is granted is 15 years, counting from the day of registration.

The patent fee payable to the Patent Office is 10 yen annually, which is increased progressively by five yen after every three consecutive years; thus the total amount of patent fees for 15 years is 300 yen. Fees payable to the Patent Office for applications are five yen ($2.50), three yen ($1.50), and 12 yen ($6.00) for first examination, second examination and for trial, respectively. Any person wishing to make an application or claim with reference to a patent, or any patentee who has no residence in Japan, is required, according to Article VI. of the Patent Law, to appoint an agent who has a residence in Japan. Such agent is authorized by the same article to represent the principle in proceedings before the Patent Office and in civil actions and denunciations with regard to patents. Thus an agent representing foreign inventors in Japan ought to be a most trustworthy and responsible person, and the uncertainty of foreign inventors as to whether they can find such a reliable agent in Japan seems to be one of the chief reasons why they hesitate to patent inventions in that country. Trustworthy agents, however, are not entirely wanting there.

There are two other important facts to be remarked about Japanese patents. In the first place, the strictness of examination of applied inventions has been mitigated to a certain extent during the last few years, and secondly, the interpretation of the words "publicly known" under Article II. of the Patent Law has recently been changed. These two facts are of great importance to foreign applicants. As to the former, hitherto the patent officers in examining the applied invention, deviated from the practical point of view, dwelling much upon the theory of the invention. Consequently, the examination operated severely upon applied inventions, and many inventions which might have been patented under a more moderate and practical examination, were held to be not patentable. But things could not go on in this way, and recently the treatment of applications has been much more moderate, and they have come to be examined from a practical point of view. As to the second fact, hitherto the Patent Bureau strictly adhered to the view that an invention is not patentable if it was made known in some other country, even if it were not known in Japan; that is to say, the words "publicly known" were interpreted to mean a state of international publicity and many foreign inventions applying for patents in Japan were rejected on the ground that prior to the application in Japan they were known in the countries of origin through the official gazette of those countries. Recently the bureau has changed its views on this point, and interprets the word to mean only territorial publicity in Japan; that is to say, invention is not patentable there only when it has been made known in Japan prior to the application. Thus many inventions which were formerly held not to be patentable under the wide interpretation of the words "publicly known," have become patentable under the new interpretation. It will not be altogether useless to add a few words on the question as to what facts contribute to the existence of "public knowledge" of an invention under Article II. of the Japanese Patent Law. In case of a foreign invention that fact chiefly consists of the exposition, in the library of the Japanese Patent Bureau, which is open to the public, of the official patent gazette of the original country containing the description of the said invention. This is the reason why foreign inventors must apply for Japanese patents prior to such exposition of their inventions, and why it is most advisable to apply as soon as possible. The above remarks refer especially to patents. With regard to trade-marks, the term of exclusive use of a registered trade-mark is 20 years and the fee payable to the Patent Office after the registration is 30 yen ($15.00).

CONNECTING-ROD BOLTS FOR GAS AND OIL ENGINES.

Mechanical World, September 22, 1905.

In view of the report lately issued by the Vulcan Boiler and General Insurance Company on breakdowns of gas engines, especially with regard to the failure of connecting-rod bolts, it may be of some interest to investigate the stresses to which they are subjected, a point which is apt to be overlooked by designers of this class of machinery. The stresses are almost entirely due to the inertia of the reciprocating parts, and while this need not be considered in steam-engine design, the steam pressure imposing a much higher stress than that due to inertia, which it also opposes, in gas-engine work they amount to quite a serious matter, especially in the larger sizes.

The calculation for the maximum inertia stresses, which are the only ones that need be considered, can be easily made by the following formulas:

$$Q_1 = \frac{P v^2}{g r}\left(1 + \frac{r}{l}\right)$$

$$Q_2 = \frac{P v^2}{g r}\left(1 - \frac{r}{l}\right)$$

where

Q_1 = the accelerating force at the commencement of the outstroke.

Q_2 = the accelerating force at the commencement of the instroke.

P = the reciprocating weight in pounds.

v = the velocity of the crankpin center in feet per second.

r = the radius of the crank circle in feet = ½ stroke.

l = the length of the connecting rod.

g = gravity = 32.2.

Q_1 will put the rod in tension, as it has to pull the piston out. Q_2 will put the rod in compression, so need not be considered.

Assuming that the connecting rod equals 2½ times the stroke, and that the weight of the reciprocating parts is equal to a pressure of 4 pounds on the piston area, which is about the average for the usual construction of piston, the formula may be simplified to the following form:

$$Q_1 = 0.00064\ d^2\ s\ n^2;$$

where

d is the diameter of the cylinder.
s the stroke in feet.
n the number of revolutions per minute.

Taking an engine with 18 inches diameter cylinder, 24-inch stroke, and 160 revolutions per minute, the pull on the bolts becomes:

$$Q_1 = 0.00064 \times 324 \times 2 \times 25{,}600.$$
$$= 10{,}650 \text{ pounds} = 5{,}325 \text{ pounds on each bolt;}$$

which with a stress of 4,100 pounds per square inch would give bolts 1½ inch diameter.

If now we increase the speed 20 per cent, giving a piston speed of 768 feet per minute, which is by no means excessive in electric-lighting engines, the strains will be increased by the square of the difference in speed, viz.:

$$\frac{5{,}325 \times 120^2}{100^2} = 7{,}675 \text{ pounds,}$$

an increase of 41 per cent, requiring a bolt 1¾ inch in diameter. Of course, any increase in the weight of the piston due to scavenging or water-jacketing devices will increase the load on the bolts proportionately.

The formula given above can be easily modified to suit any design of engine by altering the constant in proportion to the variation of the reciprocating weight above or below that given and the proportionate length of the connecting rod.

The working stress of 4,000 pounds may appear low, but when it is considered that the strain comes on almost in the nature of a blow, and that the bolts are, or should be, in a state of initial tension with the brasses hard together, the margin of safety is by no means excessive.

While the above remarks apply more especially to the big end of the connecting rod, they are of equal importance in the design of the small end, which is generally wretchedly designed in its means of adjustment, the bearing surface between the adjusting brass and the tightening screw or other device being ridiculously small, the result being that this end is the first to show signs of hammering. Some makers appreciate this, and fit a wedge piece with large bearing surface similar to that used in steam-engine practice; but these are the exceptions, especially in the smaller sizes of engines.

THE ESPIONAGE AND THE HONOR SYSTEMS.

New York Commercial.

Modern business, with its clocklike system, its minutely subdivided work, its elaborated scheme of supervision, its almost Bertillon-like methods of keeping tab upon its workers, is becoming more and more a complicated piece of machinery wherein the heart of man and the finer sensibilities of the worker have less and less place. Man is the instrument used to polish, feed, engineer and keep in motion this tremendous commercial engine that it may puff, steam and grind out wealth, more wealth. The industrial machine that grinds is so tremendous, the wealth that is ground so huge, that man, the little implement in the vast mechanism, seems but an atom.

The old personal relation between employer and worker is lost. In the new scheme of things the employer sees the worker only as a mass, only rarely or never as a unit; and then only at infrequent intervals, when he, by chance, strolls through the establishment that bears his name. The worker knows the employer only through the cunningly devised apparatus that runs the industrial machine—surely an impersonal relationship. This apparatus that to him represents his employer is a series of cunning devices that act like many eyes to spy upon him in his work, to make sure that no effort is lacking on his part to help along the grinding of the mill of gold.

These devices are time-clocks, timekeepers, time cards, floor walkers, overseers of every description and sometimes a side line of inspection on the part of his fellow worker. Personal honor, personal integrity, nobleness, disinterestedness of action as business-making elements are not looked for or taken much account of. The great factory, the vast corporation, the huge commercial house, mechanically controls in the gross, as it were, the moral principle of their working force. No man can take a bundle away from the house or factory without its being O. K.'d by a superior officer, even if the parcel contains only a pair of overshoes that he does not want to wear home.

Put a man or a boy who has been brought up on an honor system, such as ruled at Dr. Arnold's Rugby school or such as rules in many a classroom in America—put such a man or boy under such management and picture his feelings for the first day or so. He will imagine that all this espionage, this policeman-like method of insuring orderly work, is directed toward him alone. At first he will inwardly resent it as an imputation against his honesty. Later he will recognize its impersonal character and wonder if the moral sense of man has declined so that any such system is necessary.

He then sees that knots of workers here and there form informal unions to "beat the machine." The time-clock can be manipulated. One man can punch another in. He can also punch another out. When times are dull craps can be played behind the scenes and a little private pool on the races can be made, and all this against the rules.

Thefts even can occur, notwithstanding the strictest kind of espionage known in modern business. One of the houses of the most rigid discipline has yearly a number of thefts made by its employes. These cases rarely reach the newspapers, for the policy of the house is against publicity. The thief is found out, gives up his spoils, and if he makes a clean breast of it is simply dropped from the rolls. While under inquisition he has a chance to implicate a coworker, and he sometimes does this to pay off old grudges against an innocent man. Strange as it may seem, the firm sometimes believes a thief when found out, while before his crime his word would not have been of equal value.

In view of all this M. M. Atwater has been moved to ask this question and to answer it in part: Would not the firm that systematically could put a reasoned faith in the honor of the entire corps of workers be benefited thereby?

Women, as a rule, use the honor system with their help, relying upon their intuitive reading of character, and they are seldom mistaken. The schools and colleges that use the system of student government find that it works to a charm in turning out young men who can stand upon their own feet morally. If large bodies of youths can be so dealt with, why is it not possible, by putting faith in the moral sense of men in business, thus to stir it into action?

Put responsibility upon a worker and show trust in him, and he will be worthy of it—nine times out of ten. Kick him and knock him, you toughen his hide, you make him more insensible to affronts, but do you thereby increase his efficiency? Do you not take from him his self-respect, and sometimes his moral goodness?

The wise employer of the future will take the worker when he comes to him with ideals and aspirations that in later years seem a lost hermitage to be mourned, will take him, raw and green as he is, and by a courteous, considerate treatment will develop the morality of the boy, side by side with his business qualities. He will do this, not for altruistic reasons entirely, but because of the monetary returns to the house. He will know that if you treat the immature boy as a possible shirk, as a possible thief, as a possible moral delinquent, you put him in a fair way of becoming this possible thing.

A NEGLECTED POINT IN STEAM CONDENSERS.

William Booth in Electrical Review (London), September 15, 1905.

It is quite common, when calculations are made relative to the volume of air to be dealt with in a condenser, to neglect the law which governs the mixture of gases with saturated vapors. Thus, when the temperature of a condenser is, say, 104 degrees F., the pressure proper to that temperature is 1.06 pound per square inch, which represents a "vacuum" of $14.7 - 1.06 = 13.64$ pounds by gage. Supposing, however, that the actual gage reading is only 13 pounds, the additional 0.64 pound is held to be due to air, and the actual absolute condenser pressure is $1.06 + 0.64 = 1.7$ pound. It is very usual to assume that the air in the condenser is present at this pressure of 1.7 pound, neglecting the presence of water vapor.

Thus if air weighs 1 pound for each 13 cubic feet, its density in the condenser will be assumed to be such that the number of cubic feet per pound will be $13 \times \frac{14.7}{2.7} = 71$ nearly, and the air pump would require to generate nearly 5 cubic feet of volume for each cubic foot of air leakage. This view tends to the production of insufficient air pumps.

One of the laws of gaseous mixture is that "the pressure of the whole of a gaseous mass is the sum of the pressures of all its parts." A second law is that "the presence of a foreign gaseous substance in contact with the surface of a solid or liquid does not affect the density of the vapor of that solid or liquid," if there is no chemical combination between the two substances.

Rankine selects as an example in his work on the steam engine, steam at 212 F., 1 cubic foot of which weighs 0.03797 pound and exerts a pressure of one atmosphere. The pressure of one atmosphere is exerted by 0.080728 pound of air at 32 degrees F. If this weight of air be heated to 212 degrees F. it will occupy a cubic foot at the pressure of 1.365 atmosphere. Then if 0.080728 pound of air at 212 degrees be placed in a vessel of 1 cubic foot capacity with 0.03797 pound of steam also at 212 degrees F., their united pressure will be 2.365 atmospheres. Molecular equilibrium demands that each cubic foot of space in contact with water at 212 degrees shall contain 0.03797 pound of water vapor. Alone the vapor exerts

a pressure of one atmosphere. With air added the pressure is increased, yet the boiling point remains the same.

This latter fact is what is ignored, because engineers are so accustomed to consider the temperature, density and pressure above a mass of water to be three invariables. The pressure is invariable where air is not present. It is not, however, a fixed quantity when another vapor is present. Rankine, in further illustration of this law, assumes water at 50 degrees F., and a cubic foot of space containing the invariable 0.00058 pound of water vapor proper to that pressure, "whether and to what amount so ever air, or any other gaseous substance not chemically attracting the water, is contained in the same space."

This is the law discovered by Dalton and Gay-Lussac. In other words, any amount of gas may be pumped into a space filled with the vapor of water, without decreasing the weight of aqueous vapor previously existing in that space by virtue of the temperature of the water giving off that vapor from its surface.

Recognizing the law as correct, the density of the gas present with the vapor may be calculated as follows: $P =$ the pressure of the mixture, $p =$ the pressure of the vapor proper to the temperature, such, for example, as one atmosphere for water at 212 degrees F.

Then the density of the air or other mixed gas is reduced below that proper to the pressure P in the ratio $\dfrac{P-p}{P}$. Thus, to take our first example, $P = 1.7$ and $p = 1.06$. Then the density of the air $\dfrac{1.7-1.06}{1.7} = 0.38$ nearly. The density of air at 104 degrees and 1.7 pound pressure in pounds per cubic foot is

$$0.080728 \times \left(\frac{461+32}{461+104}\right) \times \frac{1.7}{14.7} = 0.0081$$

or, say, one-tenth of normal atmospheric density. But under the conditions named the density of air in a "vacuum" of 1.7 pound pressure above water at 104 degrees F. is only $0.38 \times 0.0081 = 0.0031$ nearly, or practically one-twenty-seventh of normal atmospheric density. Thus there is much less air in the condenser than would be present if the air really had the density corresponding to the pressure. It is, in fact, necessary not to neglect the law of mixed vapors. The pressure in a condenser cannot be greater than that corresponding with the temperature of saturated steam. Any additional pressure, *i. e.*, deficiency of "vacuum," must be caused by air. The presence of this air does not mean that some of the water vapor is pushed back into the condition of water, for the conditions of molecular equilibrium demand the presence of a fixed quantity of vapor per cubic foot of space proper to the temperature. A consideration of the foregoing law will help to explain why it is that the pressure gage on a boiler will sometimes fall so very rapidly when the engine is started. The steam space of the boiler has been more or less full of air while the boiler has been cold. When heated, the pressure gage reads the combined pressures of the steam and of the air, and this will be considerably above the pressure proper to the temperature of the boiler. As soon as the air is blown out, the steam pressure shows the actual temperature of the boiler.

Thus, a boiler is closed up tight, and it is then full of air. Feed is admitted, and the air is compressed, say, to 20 pounds absolute. When the boiler temperature is 300 degrees F. the air pressure will be 31 pounds, and the steam pressure will be 71 pounds. The gage pressure will be $(71 + 31) - 14.7 \times 2 =$ say, 72 pounds, and when the air is blown out, the gage will drop back to $71 - 14.7 =$ say, 56 pounds, being the gage pressure proper to 300 degrees F. of temperature, whereas the supposed steam pressure of 72 pounds is that proper to a temperature of about 315 degrees F.

In fact, it is possible that by an air trap, a boiler might be 15 degrees F. below its proper temperature, while the gage was showing full pressure. The fall in pressure will not be noticed when a boiler under these circumstances is put upon the main steam pipe, for its pressure will be maintained either by back flow from the other boilers to which, for a time, it will act as a condenser, or, if the stop valve can open only by pressure from below, there will be no flow of steam until the boiler becomes fully heated. This will explain why the putting in parallel of a boiler at full gage pressure may not have any effect in helping the work for a few minutes, but may cause the vacuum to drop considerably. Drop in steam pressure when the stop valve is opened has usually been explained to be due simply to stirring up of cooler water in the lower part of a boiler. This effect is not possible in under-fired boilers, and the explanation is simply as above.

To return to the condenser, however, if the volume, or rather weight, of air in this is not so great as the pressure would signify, but for the law of mixtures the same proportion of such weight will be abstracted by each stroke of the pump. The fact that air adds so greatly to the pressure in a condenser should, however, spur on the engineer to effect its complete elimination. The degree of approximation of the vacuum gage to the condenser thermometer is a measure of the degree of elimination of air. A good vacuum gage would be one with two pointers, which should coincide, if properly made to do so, when no air is present. The lag of the vacuum pointer will show the degree of preventible imperfection.

ZINC CASTING FOR ORNAMENTAL WORK.

Walter J. May, in Mechanical World, September 29, 1905.

For a good many purposes of inside decoration a hard-metal casting which can be bronzed or otherwise finished is a desideratum, and zinc, when alloyed with some copper, will give what is needed—that is, as a general rule; but, of course, brass or bronze is best. Each alloy has its drawbacks, however, and while brass and bronze have to be cast at from 1,700 to 1,900 degrees F., according to their composition, zinc alloyed with a small amount of copper casts well at about 800 to 900 degrees F., which is a great consideration at times, particularly when plaster molds are used. Even with fine-sand molds a metal which pours at comparatively low heat is an advantage. And assuming that decorative effect, and not value, is the object aimed at, then the most workable metal should be used.

The making of the alloy requires a brass furnace in which to melt the copper, and skill is required in alloying; but afterwards the metal can be melted as easily as plumber's solder. For the simplest form of alloy, only enough copper to break down the grain of the zinc is required, and this works out at about 92 pounds of zinc and 8 pounds of copper per 100 pounds of metal mixed. Usually, however, 90 pounds of zinc and 10 pounds of copper would be best, owing to impurities in both metals, the alloy thus made being hard and facing-up in the lathe with a good smooth surface, having a somewhat steely appearance.

Where an extra white metal is needed, an alloy composed of 88 pounds zinc, 9 pounds copper, 1½ pound tin, and 1½ pound aluminum, may very well be used, this finishing up bright and producing a white casting, the cost of the alloy being rather more. This can be cast to have an appearance almost like frosted silver, a color which is kept if the castings are coated with clear lacquer before they dull off.

In making the simple zinc-copper alloy, the copper is first melted in a clean crucible of sufficient size, and to this the zinc, in as hot a state as possible, is added piece by piece until the violent reaction ceases. Then the bulk of the zinc is added, stirring well, and then pouring into slabs or bars, afterward breaking up and remelting to insure a thorough alloy, and then pouring into conveniently-sized ingots for use when needed. With the quadruple alloy, the copper is first melted, then the aluminum and tin successively added, and afterwards the zinc, the latter entering more quietly than with the simple alloy. In the melting for pouring into the molds the metal can be melted in an iron metal-pot well coated with plumbago, care being taken that the metal is made fluid without being unnecessarily hot, and any not at once required should be poured into a bar for future use. Burning the metal should always be avoided, and equally should keeping it in a melted state for any length of time, as this latter will cause oxidation and a change of content which leads to much disappointment with the castings.

In molding in sand it is usually preferable to use a fine kind, like the Charlton brass sand, first drying and then passing through a fine sieve, and adding some pea or bean flour to the facing sand before damping down for use. It is advisable to use the sand as dry as possible consistent with good molding, and in some cases the molds may be surface-dried with advantage. Where color is not an object in the castings, the molds may be very lightly dusted with plumbago shaken through a fine cloth; but where a clean white surface is needed, this material cannot, of course, be used. A very slight dusting with steatite would be permissible, but the amount applied must be very slight. New sand, of course, will be used, but in practice, if the molds are faced with, say ½ inch of new sand and backed with floor or ordinary sand, this will answer all purposes, while it prevents undue waste of sand. Free venting to permit of the rapid escape of air and generated gases is necessary, otherwise the castings will often run up faint; but the alloys in question do not set with sufficient rapidity to prevent the formation of good castings.

Where metal molds are used, the alloys in question present only the ordinary difficulties; but they should be brushed out with plumbago or steatite to keep a good face on them, and to prevent the zinc from eating into the iron.

Plaster molds should be composed of about three parts plaster and one part finely powdered Bath brick, or some other fine sand, the actual proportions only being determinable in practice, owing to variations in the quality of the plaster. Plaster molds should be thoroughly dried before the metal is poured into them, and it is a good plan to run a little metal through such molds to insure their filling. There is necessarily some experience required before plaster molds can be satisfactorily dealt with; but this is one of the incidental experiences of molding practice.

With ordinary care the castings leave the molds very cleanly. If they are to be bronzed or otherwise treated, they should be well brushed with a fine wire brush after any tooling has been done to them. In turning, shaping, or other form of machining, keen tools should be employed, all work being done without lubricants, as such are necessary. The metal should also be polished, if necessary, instead of being burnished, as the burnisher does not work well on zinc as a rule. Where runners have to be removed, they should be sawn off with a fine hacksaw, the teeth of which allow plenty of clearance for the body of the saw, such makes as the "Star" giving plenty of clearance when new. Filing should be done with not coarser than second-cut files, and these should be kept well chalked to prevent them pinning up. Although the alloys dealt with, file with freedom when the files are kept dry and free from grease, yet when greasy they pin up very badly, and when in this condition files will not do good work. Filed work should be finished with files of successive fineness, this working up a better face than using emery cloths; but the final polish may be given with the finest emery cloth, if so preferred.

Bronzing and the like can be done in the usual way, but plating on zinc is more difficult than on brass, and should only be attempted by skilled platers.

NOTES ON THE DESIGN OF LARGE GAS ENGINES WITH SPECIAL REFERENCE TO RAILWAY WORK.

From Paper of Arthur West, read before the Philadelphia Convention of the American Street Railway Association.

One of the most important considerations in the design of large gas engines is the arrangement of the cylinders. In a single-cylinder, single-acting, 4-cycle engine an explosion takes place once in every two revolutions. In order, therefore, to get the same rotative effect as with a double acting steam cylinder, it is necessary to work four single-acting cylinders on the shaft or two double-acting gas cylinders tandem on one crank pin. With this arrangement four explosions are obtained in two revolutions, or an explosion every 180 degrees of crank angle. In case of a misfire or premature ignition due to bad gas, the crank can only move one-half a turn before another explosion takes place. In a single-cylinder, single-acting engine the crank must move two whole turns before the next explosion, while with two single-acting cylinders opposed to each other or one double-acting cylinder, the crank may be required to move one and one-half turns before the next explosion. The relative evil effects of a premature or misfire are, therefore, in the following ratios:

Two double-acting cylinders....................	1
Two single-acting cylinders, opposed type........	3
One double-acting cylinder.......................	3
One single-acting cylinder.......................	4

Gas engines and producers to be commercially successful must be designed to be run with the same class of help as is employed on Corliss engines and boilers. This being the case, misfires and prematures are liable to occur occasionally, and the designer must minimize their possibilities for evil. These considerations, as well as the capacity for caring for heavily swinging railway loads, have caused our adoption of tandem double-acting cylinders for railway work.

It is sometimes argued that cylinders so arranged are inaccessible. If, as is the practice of the Westinghouse Company, ample space is arranged between the cylinders, and if the inlet and exhaust valves are not located in the heads, but in the cylinder body and entirely above the floor level, such a gas engine is as accessible as a tandem-compound Corliss engine or as a Corliss engine driving an air compressor.

The speed of a gas engine must be adapted to the kind of generator to which it is to be directly connected and will usually somewhat exceed that of a Corliss engine of the same cylinder dimensions. The speed regulation adopted for large Westinghouse gas engines is especially suitable for generator driving, in that no conditions of changeable load or variable friction of valve gear affect the regulator. Our gas engine regulator governs the speed by means of a relay cylinder, and therefore produces results similar in type to those obtained with the relay governor used by the Westinghouse Machine Company on steam turbines. The advantage of such a relay governor with the gas engine is that the varying friction of valves with different qualities of gas does not affect the sensitiveness of the governor. Without a relay cylinder, the only way in which this result can be accomplished on large gas engines is by some form of a drop cut-off controlling the gas. This is objectionable on a gas engine, as any slight change in the speed of the dash pot very seriously affects the mixture of gas and air, with corresponding bad effect upon the regulation. Such small changes in speed of dash pots are frequent in a Corliss engine, where they cause no bad results. The Westinghouse arrangement employs no releasing gear of any kind, but secures all the advantages of regulation without its use.

The question is frequently asked as to whether large gas engines will drive alternating-current generators successfully in electrical synchronism or "parallel." This has been done for several years past in Germany with entire success, and it has also been done in a number of instances very successfully by our company. It is sufficient for our purpose to observe here that the cyclic variation—*i. e.*, the degree of departure from absolutely uniform rotation—is sufficiently small to conform with the design of generators now built for steam driving.

The European designer of gas engines has allowed himself an amount of complication in valve gear which would not be permissible under American operating conditions. The successful American machine must be as nearly "foolproof" as is the large Corliss engine. If it is not, it will fail to be a success from the purchaser's point of view—no matter what thermal efficiency may be claimed by the builders—as a consequence of such complication as the European engineers have been prone to adopt. In the designing of valve gears for large gas engines, wide range of quality of gases must be considered. In this respect the design of the gas engine is very different from that of a steam engine, inasmuch as the steam used has practically constant characteristics, differing only in such minor points as pressure and superheat. With the different kinds of gas to be met with, however, the proportions of air and gas, and sometimes of compression, are radically different, and no gear can hope to be a universal success which does not provide for meeting the widely varying conditions to be encountered in the market.

We are frequently asked, "What is the overload capacity of

your gas engine?" A clear understanding in this direction is very desirable, from the point of view both of the buyer and the seller. A gas engine and producer is thermally very much more efficient than a steam engine and boiler. It is, perhaps, not amiss to say that, with a well-designed producer and gas-engine plant, a horse-power can be delivered with one-half the cost of fuel that is possible with a well-designed steam-engine plant. The power of the gas engine, however, is limited by the total volume of explosive mixture which can be drawn into the cylinders during the suction stroke, compressed and finally ignited. This condition sets a limit which does not allow of a large temporary increase of the power, such as is obtained with the Westinghouse steam turbine by the automatic operation of the secondary admission valve. Such overload capacity is, of course, convenient for the purchaser, but it is unobtainable on a gas engine, unless the engine is largely underrated, and the purchaser should consider that this is one of the prices that he pays for the enormously increased output obtained with the gas engine per pound of coal. The overload capacity is, therefore, simply the amount which the builder rates his machine below its ultimate capacity. It has been our practice to rate our gas engines in such a way that they would have a safe overload capacity of 10 per cent. Our machines are ordinarily good for somewhat more than this, but conservative engineering requires that there be a margin of power in order that overloads may not materially reduce the speed. The above remarks on overload furnish a general guide which may be of service in selecting suitable generator capacity for a gas engine. For ordinary cases the overload capacity of the generator and that of the gas engine should be about equal, although the gas engine will indefinitely carry its overload, while the generator will not, in all cases, unless it is bought with that understanding.

The mechanical efficiency of a large gas engine is very much greater with a 4-stroke cycle than with a 2-stroke cycle, this being one of the arguments against the 2-cycle engine. It is no uncommon thing to see 2-cycle engines which do not realize as brake horse power more than 60 per cent of the work actually done by the cumbustion in the cylinders. The efficiency of a 4-cycle engine varies considerably, but it may be said in a general way that a well-designed engine will deliver about 85 per cent of the gas indicated horse power in the form of brake horse power. This 15 per cent of power lost is not exclusively composed of frictional resistance of journals, cross-head slides, etc., as is the case in a steam engine. The 4-cycle engine has, of course, to draw in its own mixture of air and gas and compress the same, and its functions, therefore, combine those of a pump, a compressor and a motor. It is the pumping and compressing work which causes the mechanical efficiency of the gas engine to be somewhat lower than that of a steam engine. The actual friction of the working parts need be no greater than with a well-constructed Corliss engine, viz., 90-95 per cent. In order to keep down the friction and increase the reliability of the machine, it is the practice of the Westinghouse Company to design large gas engines with provisions for attaching a continuous return oiling system. The large amount of oil put through the journals increases the safety, requires less attendance and keying up, and washes out dust if the engine is required to operate in an atmosphere which is not clean.

There is an impression rather prevalent that a gas engine is uncertain and hard to start. A properly designed engine,

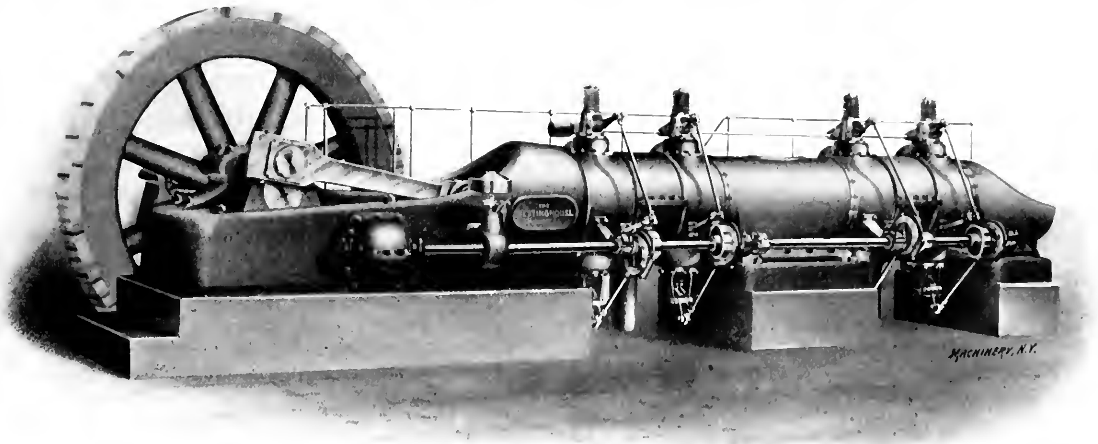


Fig. 1. One thousand H.P. Westinghouse Gas Engine for Electric Railway Service.

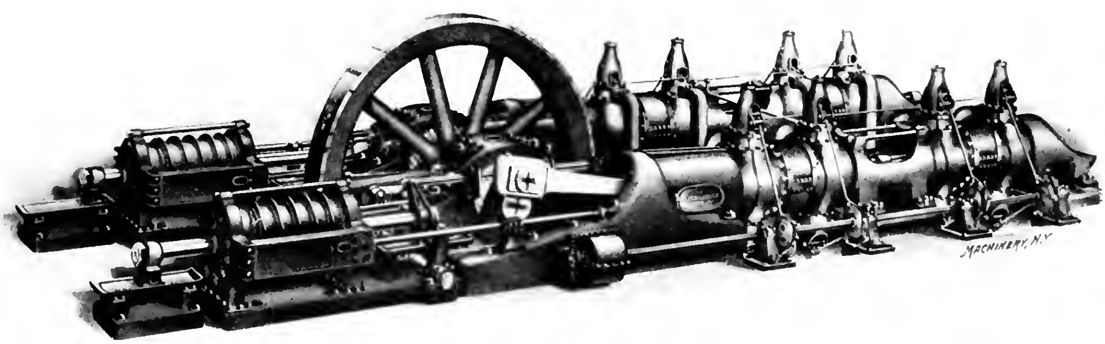


Fig. 2. Twin Tandem Blast Furnace Gas Blowing Engine.

supplied with fairly decent gas, can be started as easily as a steam engine. Large Westinghouse horizontal gas engines are started by means of compressed air, the only operations required being: (1) open the main gas valve; (2) close the igniter circuit; (3) open one compressed air valve, similar in construction to an engine throttle. The compressed air puts the engine in motion, which draws the charge into the cylinder and compresses the same, after which the first explosion takes place. Air is shut off and the engine is in full operation.

With certain kinds of gas, inspection of the interior parts of the cylinders is often desirable at regular intervals of, say, a couple of months. This is especially the case with blast furnace gas, and also with producer gas made from certain kinds of fuel. We have taken particular pains to arrange our cylinders so that no parts of the valve gear or valves are below the floor. The inlet valves being located directly on the top of the cylinder, easy access can be had to either end of either cylinder by removing the inlet bonnets. The exhaust valves are also a part of the engine which need occasional attention for regrinding. Especial care has been taken to render these quite easily removable. The cylinders are, therefore, directly accessible from the top through the inlet openings and from the bottom through the exhaust openings. The fact that all the valve parts are entirely above the floor line renders these operations comparatively easy.

The general type of engine commented on above is shown in the two accompanying illustrations. The first shows the type of two engines being built by the Westinghouse Machine Company for the Union Traction Company of Kansas, Indépendence, Kan., one being of 500-brake horse power and one of 1,000-brake horse power. The second photograph shows one of two twin-tandem furnace gas blowing engines now under construction for the Edgar Thomson plant of the Carnegie Steel Company.

* * *

MACHINE TOOL BUILDERS' CONVENTION.

The annual convention of the National Machine Tool Builders' Association was held at the Hoffman House, New York, on Monday and Tuesday, October 16 and 17. The Association now has a membership of 51, and there were over 40 present at these meetings. The following new members joined the association: E. Rivett, the Rivett Lathe Mfg. Co., Brighton, Mass.; F. W. Hoefer, the Hoefer Mfg. Co., Freeport, Ill.; W. A. Chase, National Acme Mfg. Co., Cleveland, O.; Israel H. Johnson, Jr., I. H. Johnson, Jr., & Co., Philadelphia, Pa.; George J. Burns, the Chandler Planer Co., Ayer, Mass.; Clarence Whitney, the Whitney Mfg. Co., Hartford, Conn.

The meetings of the association are held in executive session, and the business transacted is generally not for public discussion. It is stated, however, that the subject of general trade conditions and prices formed the basis of the proceedings, as is usually the case at these meetings, while there were no reports of importance from committees, relating to the changes in design or to uniform proportions for machine tools, as have sometimes been submitted in the past. There was, however, a report of delegates to the National Reciprocity Convention held last August at Chicago. It was the sense of this convention that there should be an immediate reciprocal concession to other nations to relieve the strained situation now existing, owing to our failure to carry into effect the reciprocal trade provisions of the Dingley law.

There has been a strong feeling among machinery dealers that there should be an advance in commissions by machine tool builders, and many of the latter class of manufacturers, while combating this idea, have been in favor of an advance in prices upon machine tools. The whole subject was threshed out at the several meetings, with the result that no action was taken by the convention as a whole, looking to any change either in commissions or in prices of tools. There are several standing committees, however, which have in charge the trade interests of the manufacturers of the different classes of machine tools and they may act upon the question of prices at their discretion. It is understood that the lathe committee have decided upon no advance at present, while the milling machine committee are in favor of an advance.

The officers for the ensuing year are the following: President, E. M. Woodward, the Woodward & Powell Planer Co., Worcester, Mass.; first vice-president, William Lodge, the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio; second vice-president, W. P. Davis, Rochester, N. Y.; treasurer, F. E. Reed, Worcester, Mass.; secretary, P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio.

On Monday evening a banquet was held at the Hoffman House by the association, where members and their guests listened to addresses by Charles A. Moore, of Manning, Maxwell & Moore, New York, and Fred J. Miller, editor of the *American Machinist*.

Mr. Moore spoke upon the possibilities of foreign trade for American machine tool builders, and talked interestingly, giving the results of his experience and observation, extending over the many years that he has been so intimately associated with the machine tool trade. He contended that American tools were well thought of abroad, but that our merchants had not been as progressive nor as aggressive in disposing of their products as had our new competitors, the Germans, or even our old competitors, the Englishmen. Frequently the American manufacturer failed to secure foreign orders because he did not understand the conditions to be met, and even when he was successful he ran across disadvantageous conditions, as for example, the lack of banking facilities, except through London exchange.

Attention was called to several practical aspects of the case, as, for example, the necessity for careful boxing and shipping; since, when a foreign buyer receives a tool that has been damaged in transportation, there is a long delay before the damaged parts can be replaced, and the matter finally adjusted.

Mr. Moore dwelt at length upon tariff and reciprocity, and while expressing himself as favorable to any revision of the tariff law which would affect a considerable number of industries favorably, he advocated the present policy of protection under which the country has thrived, and cautioned his hearers against any proposition looking toward a sudden or radical change.

Mr. Miller read a paper upon government manufacturing in which he outlined some of the reasons why the manufacturing establishments controlled by the government operate at a disadvantage, as compared with independent concerns.

He advocated a cabinet department of manufacturers having a secretary of manufacture at its head who should be a practical manufacturer accustomed to organizing industrial establishments. The business of manufacturing by the government should then be removed from the control of the army and navy, and placed under the care of this cabinet officer. In other ways such a department would prove beneficial in bringing together the various testing departments or bureaus, and thus making standard the method used by the different ones. The manufacturing operations of the government should be carried on not by sailors and soldiers, but by manufacturers.

MACHINERY'S Annual Outing.

The entertainment of the Association and its guests by MACHINERY has assumed the form of an annual outing which will be given by this paper every year about this time. On the above occasion about three hundred and fifty manufacturers and dealers accepted MACHINERY's hospitality on a trip around Manhattan Island on a steamer chartered for that purpose, leaving the foot of West Twenty-second Street at 1:15, Tuesday afternoon. After luncheon was served the entire party visited the Brooklyn Navy Yard; an hour was allowed for inspection of the interesting work in progress at this important naval station. The steamer then proceeded up the East River through the Harlem River and Spuyten Duyval Creek to the Hudson, and returned to the Twenty-second Street pier at about six o'clock. The sail through the Harlem River, which separates Manhattan Island from the main land, was particularly interesting. In order to follow this course it was necessary for twelve draw-bridges spanning the river to be opened to enable the steamer to pass, but there was no serious delay at any point.

This outing was the means of bringing together the largest and most representative assemblage of machine tool builders that has ever gathered at a single meeting place, and undoubtedly accomplished its principal object—the promotion of acquaintance and good fellowship among the trade.

TURRET TOOLS FOR DRILLING HOLES IN CAPSTAN-HEAD SCREWS AND NUTS.

C. V. RAPER.

There are a great number of manufacturers besides those producing scientific instruments and the like, who possibly have occasion to, or do use, both capstan-head screws and nuts, and probably in the case of the ordinary machine tool maker the nut is more in demand. But the employment of these good looking and compact adjuncts to machine construction is probably militated against, to a great extent by the fiend "Cost," which looms up at every point of the design of a machine. Speaking metaphorically, the tools to be discussed are the result of an attempt to exorcise the demon of expense and bring into more general use the capstan-head screw and nut.

The tool shown in side elevation and part section at Fig. 2 and in end elevation at Fig. 1 embodies and shows the main principle applied by myself to tools of this nature as used in connection with the semi-automatic type of turret lathes and automatic screw machinery, especially the latter. The screw, shown in the latter portion of its formation in position at Fig. 2 before it has parted company with the "parent" bar stock, is about to have the four holes drilled in the head; this screw, finished, is shown at Fig. 5. Referring to Fig. 2, the turret carrying the tool is supposed to have traveled up to the half-finished screw, which only requires threading and cutting-off to complete its manufacture as far as the "automatic" is concerned.

The shank of the screw enters the tool-steel spring collet F and butts against the adjustable stop H, forcing the collet inward and causing it to grip the screw tightly. The rotary motion of the bar is thus transmitted immediately to the collet and from thence to the machine steel bearing sleeve B by means of the tool-steel keys K. Play is allowed for the keys in F and B to compensate for both the butting and subsequent withdrawing movements of the turret. Keys K are similar to those denoted by K_2, shown at Fig. 4.

part of Fig. 2 which is let a short way into both the carrier head and the machine-steel driving bevel pinions M; the bevels rotate the carriers by means of key P, the slot in the carrier running out at the tail end. These bevel pinions are carried by the sleeve B and rotate bodily with it, planet-wise, receiving revolution about their own axes by gearing with the fixed bevel J, which is of phosphor bronze and acts in addition as a sort of steady bearing for B. J is secured to the gray iron end plate X_2 by means of four cheese-head screws. The bearing part is lubricated by a small hole drilled at an angle to the surface. It will now be seen that on the turret gaining position, the drills will revolve rapidly. The feed is the next and altogether the toughest problem to digest.

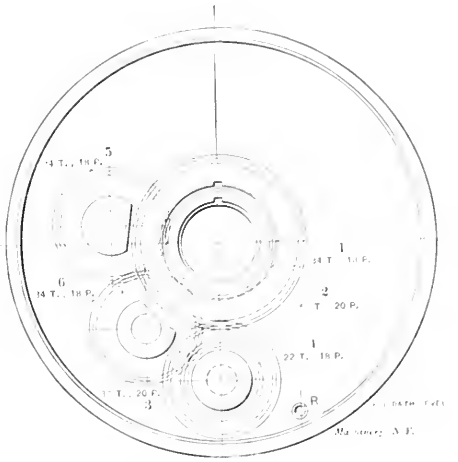
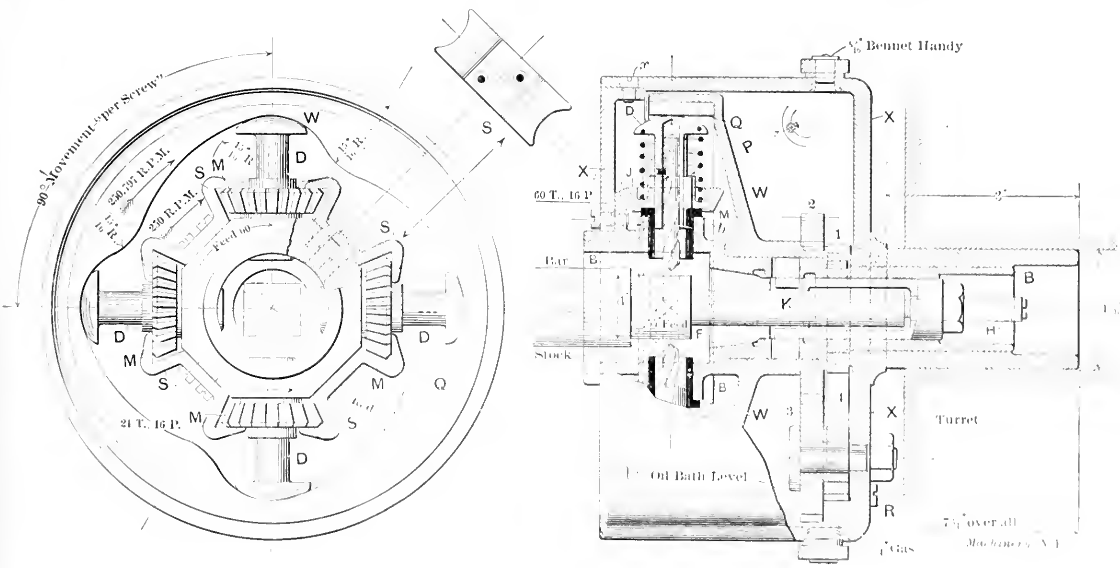


Fig. 3. Geared Drive of Feed Cam.

The feed is obtained by the cam Q, which is of hard tool steel, driven into the dished casting, W. One-sixth of a revolution of Q completes the feed and on the full one-fourth revolution being obtained, the drills have sprung back and everything is in readiness for another cycle. That is to say, the dished casting W and consequently the cam, of course, must travel slightly faster than the sleeve B; this is effected by the train of gears shown in Fig. 2 and the end view, Fig. 3. No. 1 gear is keyed to B and drives through to 4 by the intermediates 5 and 6; 4 and 3 are fast together, and consequently rotate 2, which is keyed to W. One rotation of sleeve B gives W 629/627 turn; hence, with B running at 250 R. P. M., the gears turn the cam 0.797 revolution per minute faster than the sleeve and drills. The feed, as shown by Fig. 1, is completed



Figs. 1 and 2. Drilling Attachment arranged for Drilling Capstan Screw Heads.

Referring to the end view, Fig. 1, it will be seen that B carries an octagonal shoulder solid with itself. Holes are reamed through any two pairs of opposite flats, to admit of the four hardened cast-steel bushes, b, Fig. 2, which are a good fit and are secured by grub screws. These bushes act as bearings for the non-hardened high-grade tool-steel drill-carriers D. The carriers are reamed out to take the drills, which are high-speed steel and of the ordinary straight shank type with the exception of a slot cut to take the holding grub-screw, the slot allowing for adjustment of drills for grinding, wear, etc. Each carrier is held in position when the tool is out of action by the weak spring shown in section in the upper

when cam Q has turned through 60 degrees in advance of the drills, sleeve, etc.; the remaining part of the full 90 degrees is taken up in allowing the drill carriers to slip back ready for the bar to withdraw (or rather for the turret to recede). The drills depend greatly on the centrifugal force to return them, the springs being weak. The rate of feed to the drills in this case runs to about 2.625 inches per minute, the actual distance fed being 0.55 inch. Taking the bar to run at 250 R. P. M., and with the fixed gear J having 60 teeth and the pinions 24 teeth, the drills will run at 625 R. P. M., which speed and the before-mentioned feed are averages for good high-speed steel drills (in mild steel only).

The peculiar shaped castings S are of phosphor bronze, and serve to keep the pinions from getting out of gear under the action of the centrifugal force exerted on them by reason of their planetary motion.

The drills are lubricated by an inclined jet of lard-oil in the usual manner. The cuttings from the drills will be found to take care of themselves, providing the relative sizes of bar and aperture are of a similar proportion to that in the sketch, being partly rolled, drawn, and partly shot out by the rotary movement of the turret.

This tool, with the addition of a few liners and adjusting screws, like H, will take any size of screw below the maximum

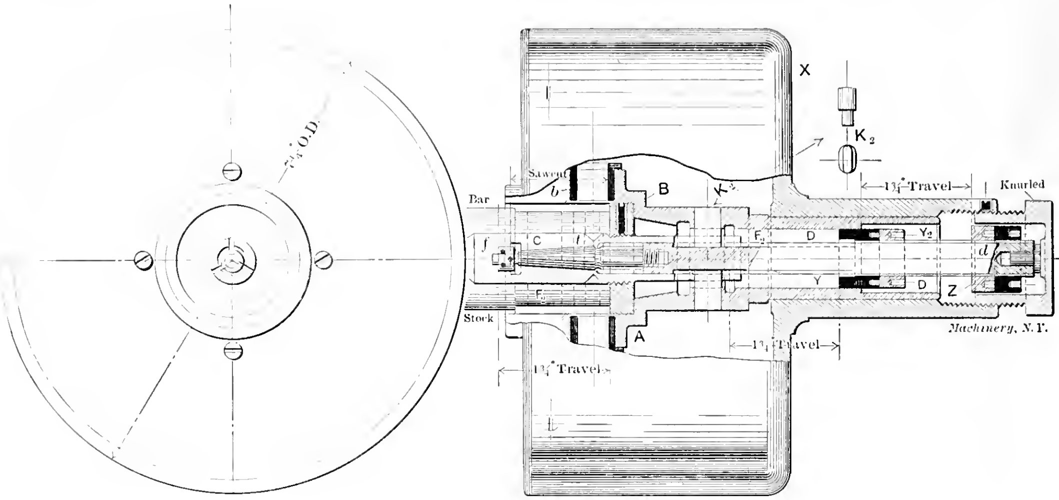


Fig. 4. Drilling Attachment arranged for Drilling Capstan Nuts.

This cam motion, while being delightfully simple and certain, has the objection (if it be one) that the holes are not drilled completely through the head. To do this, a cam should, of course, be designed which would give two of the drills intermittent feeds after the other two had gone to a similar depth to that of the present tool; this would remove the small amount of metal left. This proposed cam, however, would necessarily be complicated and would require a "reverse" setting after the manner of a certain class of self-opening die-head, thus doing away with the absolute automatic action of the tool as it is at present. But I cannot see that it is a very important failing, as one seldom puts a tommy-bar further in the hole than the depth shown as drilled in Fig. 5.

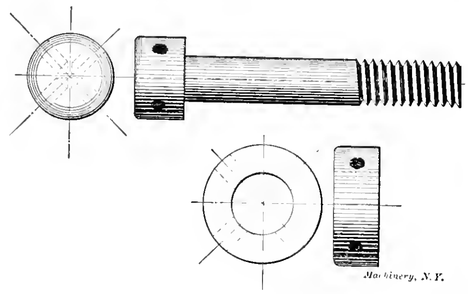


Fig. 5. Capstan Screw and Nut with Holes Drilled in Screw Machine.

The maximum diameter of screw-head this particular tool will take for a given outside over-all diameter of 7¼ inches, is a little more than one inch. The shank of the gray iron body could be reduced somewhat if cast in some tougher metal, such as "Harrison's steel alloy," a product of Lincoln, England, which combines the usual qualities of a steel casting with excellent machining and bearing features. Lubrication of the gears and cams is effected by an oil bath which can be replenished or drawn off by the two machine-steel plugs shown at Fig. 2, which are further fitted with "Bennet Handy" oilers. The bath is tested for quantity by the examining plug R, the center of which is the oil-bath level. See Fig. 2. Fig. 1 shows the bevels and carriers with springs and drills removed.

given. The construction, though seemingly complicated, is fairly simple; it is very easy to set, for to withdraw the drills, sleeve, etc., one has only to remove the four screws x, when the whole works can be drawn out, leaving only that part of the gear train which is secured to X. The drills can then be removed at once by slacking the grub screw in the carriers. It will be apparent that the number of drills may be three, four, five, six, or even eight, should requirements demand it; usually, however, four are adequate.

Fig. 4 shows the same tool fitted up to drill the nut shown at Fig. 5. In this case the hole (which should have a rose-reamer run through in a previous operation) is not yet tapped so that it may be gripped by the internal spring collet F_2. On this is screwed the adjusting butt collar A, of which one is required for each thickness of nut. The collar is tapped and locked on the screwed part of F_2 by a brass grub-screw. The groove t on F_2 allows the drills to make clear holes. The hardened cast-steel plug C screws into the arbor D, which fits without shake into the end of F_2. Key slots are cut in both D and F_2 to receive the driving keys K_2. The further end of D has a fine thread, on which is the bearing nut Y and its lock-nut Y_2, which adjust to suit the varying widths of nuts; these last only serve to steady the arbor D, which is prevented from being withdrawn by nut Z. Driven into the end of D is the tool-steel plug d, which butts against the knurled shell-nut G, which is adjustable to suit the exact travel of F_2 on C after the conical surfaces come in contact. The work should butt up on A, and the pin d on G, simultaneously.

This adaption of the tool enables it to clear the cuttings out by the withdrawal of the turret, and, as shown, the "clearing" is accomplished in 1¾-inch travel. It will be observed that with the exception of the bushings b, the sleeve B is pecisely as in Fig. 2.

* * *

Mr. C. W. Shelley, Wallingford, Conn., advises us that cornstarch is preferable to chalk in the receipt for die-makers' wax published in the October issue of MACHINERY. The use of chalk was recommended to prevent stickiness, but cornstarch works better as it makes the grain of the wax finer, thus showing up lines more distinctly.

THE "LO-SWING" LATHE.

A glance at the accompanying cuts will be sufficient to convey the information that this lathe, called by its makers the "Lo-Swing" is very far from being a representative of standard practice. Its builders, the Fitchburg Machine Works, Fitchburg, Mass., set out with the idea of making it a single purpose machine. Provision is made for turning work from $3\frac{1}{2}$ inches in diameter down, of any length up to 60 inches, and they have made provision for nothing further. It will not take work of larger size, it cannot be used as a chucking machine, nor can it cut a thread without special attachments not regularly furnished. A little thought will convince any one that by far the greater part of the lathe work in the ordinary machine shop falls fairly within these limitations, and if a machine is designed to work within these dimensions and take care of every possibility for improvement which this range allows, it should be able to do its own work better than can the standard machine.

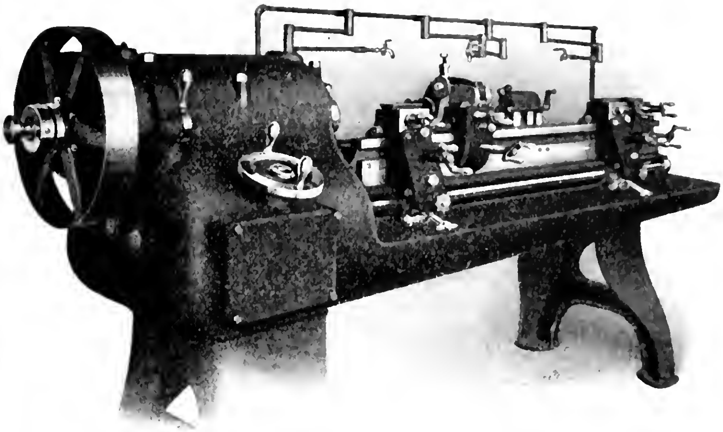


Fig. 1. Front View of Lathe at Headstock End.

Figs. 1 and 2 show the general arrangement of the lathe. The bed, oil pan, and headstock are cast in one piece. The machine is driven by a fast-running belt on a 12 inch pulley, from which it is never shifted, the seven spindle speeds furnished being obtained through gearing in the headstock. Fig. 1 is a top view of the headstock with the cover removed. In the hub of driving pulley A is mounted a bolt, B, which may be shifted by its handle to engage latch pins in either collar C or gear D. When in engagement with collar C, the spindle, through it, is driven directly; when in engagement with gear D, which is loose on the spindle, motion is transmitted through gear E to auxiliary shaft F. A pinion integral with this shaft, and two gears L and O mounted on it, drive respectively the three gears, G, K, and N, which thus revolve loosely on the spindle at varying rates of speed. If knob H at the left-hand end of the spindle be pushed inward, collar J, which is keyed to the spindle, will be moved to the right, engaging the driving pin I with the latch pin in gear K, thus locking this gear to the spindle. In a similar manner, by pulling out knob H, gear N will be locked to the spindle. If collar J is in a central position, as shown in the cut, both K and N will be disconnected and the spindle will be driven by gear G. This gear has a ratchet arrangement, not clearly shown in the cut, by which it normally engages flange Z, which is pinned to the spindle. If, however, the spindle is connected at any time to a higher speed gear, this ratchet, which is noiseless, will allow the spindle to take a faster gait. A handle which may be seen at the front of the headstock in Figs. 1 and 2 throws in back gears Q to transmit the motion from pulley A to gear D. All these gears run in oil. The seven speeds given by this mechanism range between 50 and 560 R. P. M. The changes cannot be made while the machine is running, but it was deemed advisable to sacrifice this point to secure simplicity of design. The live center is in the form of a button, set in a recess in the end of the spindle. The tail of the dog is driven by a stout pin, which passes through the spindle nose.

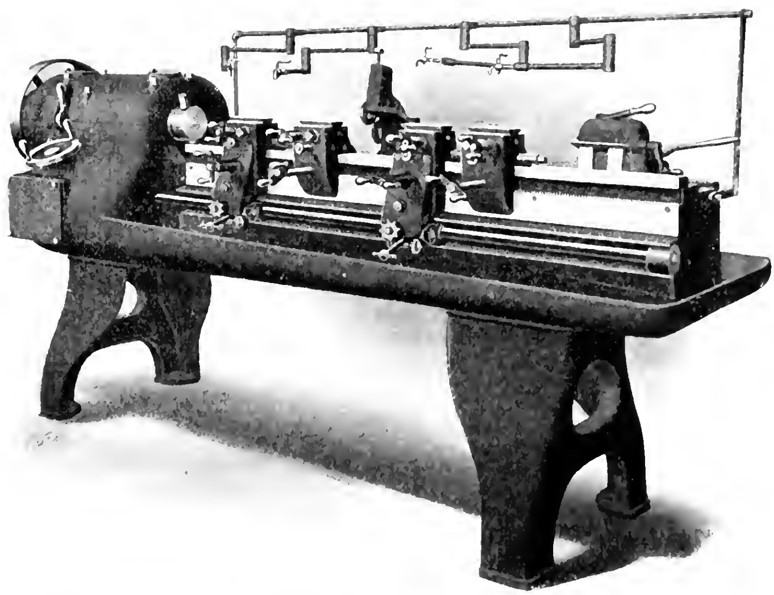


Fig. 2. Front View of Lathe from Tailstock End

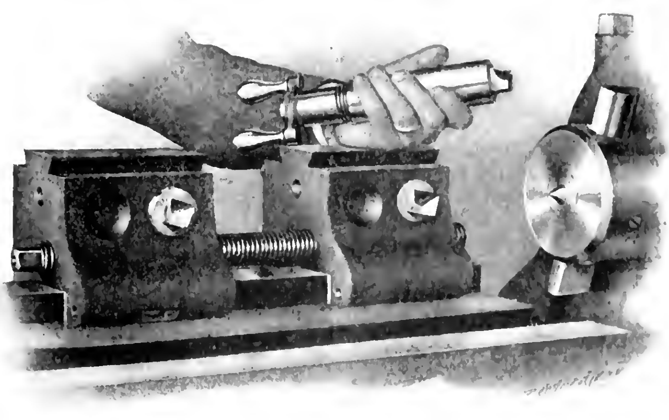


Fig. 3. The Carriages and Toolholders

The chief interest of the machine centers

around the arrangement of the carriages, and the tool and work supports. Fig. 3 gives a good idea of the design of the carriage and the rigidity which is obtained by bringing the ways on which it slides up as near as possible to the point of the

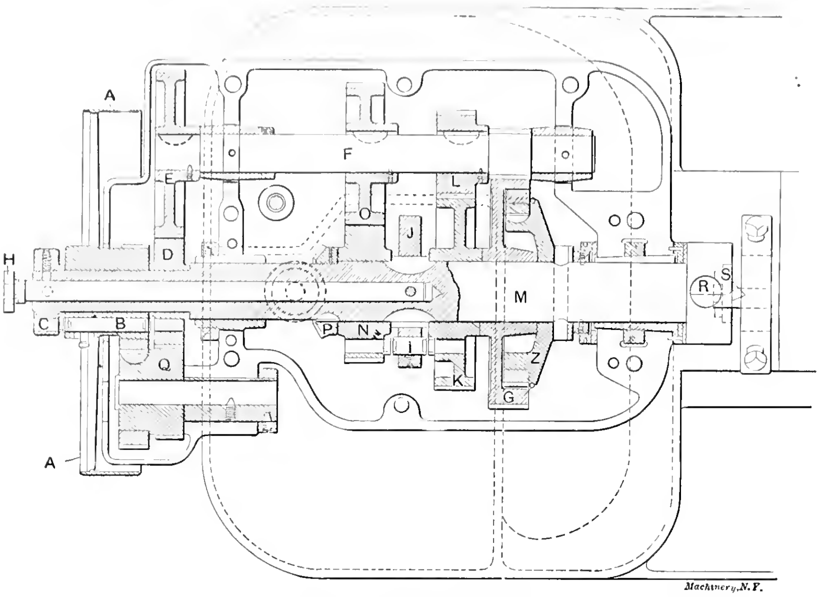


Fig. 4. Spindle Driving Mechanism.

tool. There is a great difference between the degree of rigidity which is attained by this construction and that possible in an 18 or 20-inch lathe of usual design, especially if the latter is furnished with a compound rest, in which case the point of the tool may be anywhere from 8 to 15 inches from the guiding surface of the V's, with the connection between them made up of a multiplicity of joints and sliding surfaces. Here the cutting point is directly over the bearing and the number of fits between the tool and bearing is reduced to the smallest possible number. The tool itself is machined to fit in a sleeve, which may be seen in the hand of the workman in Fig. 3. The inner end of the cross motion screw bears on the end of the tool,

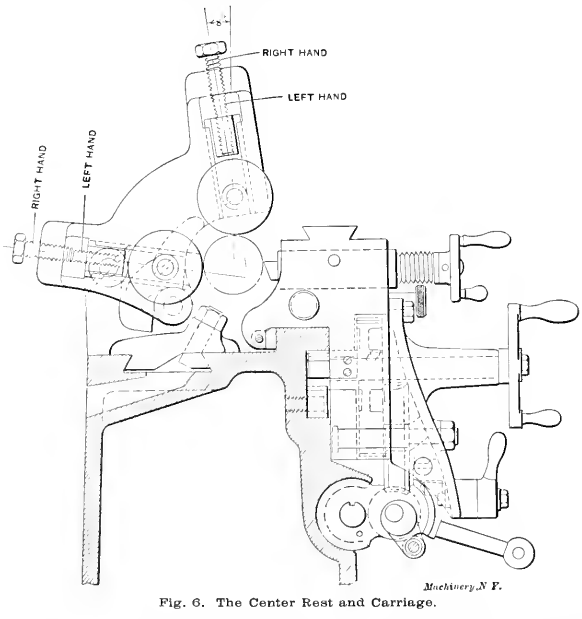


Fig. 6. The Center Rest and Carriage.

giving an absolutely direct action. A yoke engages notches at the end of the tool and thus draws it out when the screw is turned back. The sleeve with this leadscrew and tool is put in through one of the two holes shown in each carriage. In the other hole is placed an eccentric clamp which binds the sleeve in any position desired. As may be seen from Fig. 2 there are four carriages furnished regularly with the machine of which two only have power feed. Each of the carriages with feed carries another with it at a distance which may be regulated by turning the adjusting screw which connects them. On a shaft long enough to allow it, four different cuts may thus be taken at once; two in one direction and two in the other, if conditions warrant such a proceeding. Since they are only about 5 inches wide, the tools in the adjacent carriages may be brought very close to each other, and their light weight allows them to be handled with extreme ease. Variation in feed is obtained by turning the double handled wheel which may be seen at the front of the headstock. This operates a modified form of Sellers' friction drive.

Fig. 5 is a line engraving of the tailstock. It is mounted, as shown, in separate ways on the rear of the bed, and is of such form that it offers no interference to the movement of the carriages,

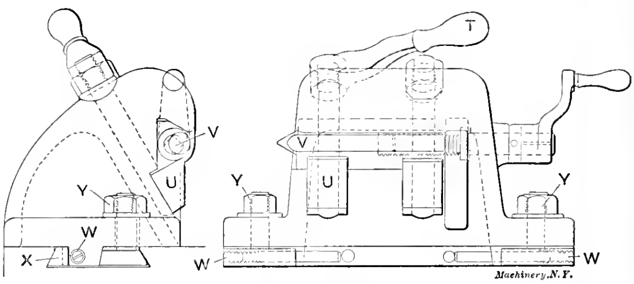


Fig. 5. The Tailstock.

which may be moved back and forth across its face at will. Handle *T*, through hook bolt *U*, serves to clamp the triangular body of the center *V*. A crank is furnished for moving the center in and out. Adjusting screws, *W*, give a longitudinal movement to the taper gib, *X*, thus serving to line up the center laterally with the spindle. Nuts *Y* clamp the tailstock in place by obvious means.

The back rest and follow rest idea, which has been found so useful in screw machine practice, has been adapted to suit the design of this machine. Fig. 1 shows a follow rest clamped to the ways provided for it on top of the tool carriage. A similar center rest is shown in Fig. 6, which is a cross section of the bed near one of the main carriages. This follow rest is clamped to the surface on which the tailstock slides, and like the tailstock, offers no interference to the carriage. Owing to the high speeds at which the work may be run with modern tool steels, the usual form of stationary jaws for the follow and center rests has been discarded, and a roller rest introduced in its place. A neat arrangement will be noted in the design of the adjusting screw for these follow and center rest jaws. It is made in two diameters, one of which is threaded right-hand and the other left-hand, screwing respectively into the main casting and jaws. This construction does away with the necessity for a collar.

One result of the rigid support which the design of this lathe gives to the tool, is the fact that the cutting edge lasts much longer and may be given a much sharper angle than is possible with a standard lathe. It is well understood nowadays that the great destructive factor at work on the cutting edge, is not the wear due to the friction of the

chip. When a heavy cut is being taken the chip is split off from the stock a perceptible distance ahead of the tool and the edge itself often does not come in contact with the chip, which strikes the tool considerably to the rear. This action is especially noticeable in cutting steel, when a perceptible groove is ofttimes worn just back of the cutting edge. The factor that breaks the edge of the tool, is the lateral vibration which is allowed by the usual tool post and carriage. It is claimed to be possible, with a lathe constructed in the manner of this one, to carry a much sharper cutting angle than heretofore, since the rigidity of the design almost eliminates the lateral vibration and thus makes it unnecessary to blunt the angle of the tool edge to keep it from breaking. A sharp cutting edge will of course require much less power and consequently work with less friction and heat than will a blunt one.

This machine was designed by Mr. James Hartness, of Springfield, Vt., as may have already been surmised by those familiar with the general lines and details of the flat turret lathe. Mr. Hartness, however, has no official connection with the Fitchburg Machine Tool Co.

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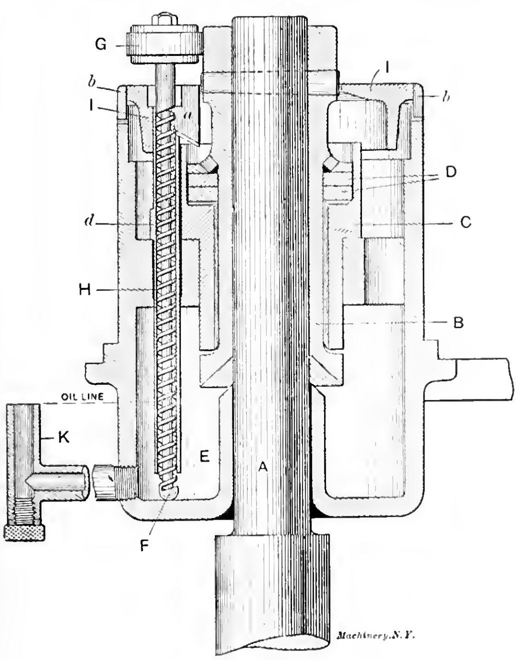
AUTOMATIC OILING DEVICE FOR ARMATURE BEARINGS ON VERTICAL MOTORS.

The problem of oiling armature shaft bearings on a vertical motor is not only to keep the bearings well lubricated, but at the same time to prevent oil from getting on to the commutator and armature windings. In a vertical motor the bearings must take care not only of the side pressure of the shaft, but the end thrust due to the weight of the armature shaft and attached parts as well. The Northern Electrical Mfg. Co., Madison, Wis., use an ingenious and simple combination in connection with their line of vertical motors which is said to effectually fulfill the requirements outlined in the foregoing.



Oiling Device for Vertical Bearing.

In the sectional view of the bearings shown in the accompanying cut, *A* is a portion of the armature shaft reduced for the journal; the journal proper, however, is the bushing *B*, which is formed at its lower end so that the excess oil runs off into the reservoir without tending to follow the shaft. The bushing is pinned to the shaft at the upper end, and is fitted to the brass or bronze bearing *C*, which latter is formed into a seat at the upper end to contain the thrust washers *D*. A corresponding flange is turned on *B* for the thrust bearing, and is perforated with a number of oil holes for admitting the lubricant. The upper end of *B* is turned to form a driver for the friction roller *G*, which is attached to the upper end of a screw conveyer. This conveyer runs inside of a tube, which is loosely fitted to the main casting *H*; to the upper end of the tube is snugly fitted the cover casting *I*. The oil brought up through the tube is discharged by spout *a* into the cup of the thrust bearing where it passes through the oil holes into the thrust bearing and from thence into the journal and reservoir *E*. In this manner a continuous supply of oil is furnished the bearing, while the motor is running; in fact, it is flooded with oil so that the best possible lubrication is always obtained

In order that the friction roller *G* may be held against the driving collar with sufficient pressure to drive it at all times, a simple and ingenious expedient is applied. The cover casting *I* is eccentrically supported so that the side thrust pushes the roller *G* against the driving collar. The cover casting is kept in position sideways by two projections *b*, which fit into notches in the upper edge of the main casting. It is carried by the conveyer tube which loosely fits in the casting at *H* and rests upon a lug on one side at *d*, thus supporting it on one side only so that its weight rocks it over until the roller *G* comes into contact with the driver. These parts form a unit and may be lifted out at any time for inspection, without removing screws or other fastenings.

When the motor is to operate in both directions, the conveyer is cut with both right- and left-hand screws, and even though the continuity is broken and it would seem that one screw would tend to undo the work of the other, sufficient oil is carried up to insure thorough lubrication at all times. In order to prevent too much oil being placed in the reservoir, an open filling tube *K* is used, which serves at the same time as a means of gaging the depth of the oil in the reservoir.

* * *

THE CREATION OF DRAFT.

A treatise on mechanical draft published by the B. F. Sturtevant Co. says that although the ultimate object of any means of draft production must necessarily be to create draft or velocity sufficient to provide the required amount of air and to carry off the gases, yet this portion of its work is almost infinitesimal as compared with the demand made for sufficient pressure to overcome the resistance of the fuel and the boiler. In other words, the ability to create sufficient pressure difference is the primary requisite for burning a given quantity of fuel, rather than the ability to move a certain amount of air. Draft-producing apparatus is not, therefore, to be based merely upon the total number of cubic feet to be moved per hour, as determined by multiplying the coal consumption by the allowance of air per pound of coal. If this were the case, a low chimney, or a large slow-running fan, would meet the requirements. In reality, the relatively immense resistances of fuel and boiler demand that the chimney or fan shall first be designed to create sufficient intensity of draft to overcome these resistances and to create the requisite velocity. This velocity must be such that, if multiplied by the full area at which it is measured, the product will equal the volume of air necessary for the combustion of the stated amount of fuel. The height of chimney or the diameter and speed of fan necessary to create the draft thus shown to be required having been determined, it is only necessary to make the capacity such as to accommodate the given volume of air.

* * *

Since the advent of high-speed steel, one of the stock jokes concerns the man who used a high-speed drill for ratchet drilling and then complained that it did not cut any faster than the ordinary kind. But, nevertheless, it appears from experiments that have been made that high-speed drills are superior for drilling rails with a ratchet or hand-drilling machine, to the carbon steel drills. The gain is not, of course, because the high-speed drill cuts faster, but because it can be used so much longer without regrinding. The Rich flat drill, a special form of high-speed drill for rail drilling, has drilled 1,600 holes one inch in diameter in 80-pound rails without being reground, whereas 50 holes with the ordinary twist drill would have been considered a good performance. Another interesting comparison has been made in the New York Navy Yard, where one of these drills drilled ten 1¼-inch holes in turret armor plate without re-sharpening, while eight twist drills of carbon steel were used for finishing one hole.

LETTERS UPON PRACTICAL SUBJECTS.

HEROIC METHODS IN THE MACHINE SHOP.

Editor MACHINERY:

Reading the account of the repairs to a hydrostatic press in the August MACHINERY, I was reminded of a remark I once heard made by an old man who was foreman of a blacksmith shop: "Only two blacksmiths ever went to hell, one for working with hot tongs, and the other for hammering cold steel."

We see the results of such "heroic" methods in every machine shop. Holes are drilled in the drill tables, the ways of the lathes are cut and the *heroes* are using the planer platens for an anvil with a monkey wrench for a hammer. They probably "get there," but they used a Stilson wrench on finished brass pipe and set up the nuts with a hammer and chisel. While there are some men who are unnecessarily cautious, a larger number will be found to be more or less "loose" in their methods.

In the repair job mentioned, if the man who turned the fits had taken a little more time in measuring his work perhaps he could have gotten his work together without breaking his press. If Mr. Davis had squared the end of the bronze valve stem in a lathe perfectly straight and smooth, and had made a good seat, the valve would have been tight enough for all practical purposes. If the valve leaked it would not take half an hour to grind it. The "sledge hammer" method was a dangerous proceeding; there was danger of bending the bronze rod in the middle, causing the end to bear unevenly on the seat and leak anyway.

At one time I was fireman in a power station. The gage cocks were of the well-known type, opened by pulling a chain and closed by a weight on the end of the stem.

One day one of them leaked quite badly, and my "opposite" in coming on duty remarked that he would fix that "right off quick." He gave the chain a tremendous yank; it parted in the middle. I left him pounding on the weight with a hammer. It is unnecessary to state I found the gage cocks still leaking when I came on duty again and they leaked till I had a chance to reduce the steam pressure to two or three pounds and take the valve out and face off the end.

I think the old proverb: "What is worth doing at all is worth doing well," applies to machine work as well as other things. If any of the readers doubt this, they should hunt up their old reading books they had when they went to school and read the old story they used to read about "Jim! Jim! The pig is out!"

Portland, Me. H. K. GRIGGS.

PROPORTIONS OF COUNTERBORES.

Editor MACHINERY:

I saw an article in the August issue of MACHINERY pertaining to twist drills. I thought a great deal of the way in which the formulas and table were put up, as well as of the general information given in regard to the making of such drills. As tables of like character must be of great value to toolmakers and manufacturers, I herewith submit a similar table with formulas and a few remarks in regard to the making of counterbores

Dimensions have been given in relation to the diameter of the body of the counterbore *A*. As counterbores are used as well with straight shanks as with taper shanks, I thought the simplest and most universal way of putting up the formulas and table would be to do so with reference to straight-shank counterbores only; but as there is no reason to make the total lengths different for counterbores with straight or taper shanks, the formulas will also hold good for counterbores with taper shanks of reasonable proportions, as will also the dimensions for *B* and *C*. As the Morse standard taper shanks are more used than any other standard taper shanks, for the convenience of the readers I herewith give an auxiliary table giving the numbers of Morse taper shanks that ought to be used with certain size counterbores.

Diam. of Body, inches.	No. of Morse Taper.
¼—½	1
17-32—⅞	2
29-32—1⅜	3
1 13-32—2	4
2 1-32—3	5

In the following formulas:

A = diameter of body.
B = length of body.
C = length of guide.
D = length of shank.
E = diameter of shank.
F = diameter of neck.
G = total length.

For counterbores from ¼ to 1 7-16-inch the following formulas should be used:

$$B = \frac{4A}{3}$$

$$C = \frac{3A}{4}$$

$$D = A + 2\tfrac{1}{4}.$$

$$E = A.$$

$$F = A - 1\text{-}32.$$

$$G = 7A + 3\tfrac{1}{8}.$$

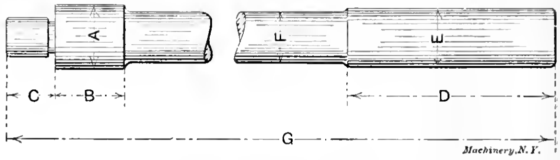


TABLE OF COUNTERBORE DIMENSIONS.

A	B	C	D	E	F	G
1/4	11/32	3/16	2 1/2	1/4	7/32	4 7/8
5/16	13/32	15/64	2 9/16	5/16	9/32	5 5/16
3/8	1/2	9/32	2 5/8	3/8	11/32	5 3/4
7/16	19/32	21/64	2 11/16	7/16	13/32	6 3/16
1/2	21/32	3/8	2 3/4	1/2	15/32	6 5/8
9/16	3/4	27/64	2 13/16	9/16	17/32	7 1/16
5/8	27/32	15/32	2 7/8	5/8	19/32	7 1/2
11/16	29/32	33/64	2 15/16	11/16	21/32	7 5/16
3/4	1	9/16	3	3/4	23/32	8 3/8
13/16	1 3/32	39/64	3 1/16	13/16	25/32	8 13/16
7/8	1 5/32	21/32	3 1/8	7/8	27/32	9 1/4
15/16	1 1/4	45/64	3 3/16	15/16	29/32	9 11/16
1	1 11/32	3/4	3 1/4	1	31/32	10 1/8
1 1/16	1 13/32	51/64	3 5/16	1 1/16	1 1/32	10 9/16
1 1/8	1 1/2	27/32	3 3/8	1 1/8	1 3/32	11
1 3/16	1 19/32	57/64	3 7/16	1 3/16	1 5/32	11 7/16
1 1/4	1 21/32	15/16	3 1/2	1 1/4	1 7/32	11 7/8
1 5/16	1 3/4	63/64	3 9/16	1 5/16	1 9/32	12 5/16
1 3/8	1 27/32	1 1/32	3 5/8	1 3/8	1 11/32	12 3/4
1 7/16	1 29/32	1 5/64	3 11/16	1 7/16	1 13/32	13 3/16
1 1/2	2	1 1/8	3 3/4	1 1/2	1 7/16	13 3/8
1 5/8	2 3/32	1 7/32	3 15/16	1 17/32	1 15/32	13 3/4
1 3/4	2 3/16	1 5/16	4 1/8	1 19/32	1 17/32	14 1/8
1 7/8	2 9/32	1 13/32	4 5/16	1 5/8	1 9/16	14 1/2
2	2 3/8	1 1/2	4 1/2	1 21/32	1 19/32	14 7/8
2 1/8	2 15/32	1 19/32	4 11/16	1 23/32	1 21/32	15 1/4
2 1/4	2 9/16	1 11/16	4 7/8	1 3/4	1 11/16	15 5/8
2 3/8	2 21/32	1 25/32	5 1/16	1 25/32	1 23/32	16
2 1/2	2 3/4	1 7/8	5 1/4	1 27/32	1 25/32	16 3/8
2 5/8	2 27/32	1 31/32	5 7/16	1 7/8	1 13/16	16 3/4
2 3/4	2 15/16	2 1/16	5 5/8	1 29/32	1 27/32	17 1/8
2 7/8	3 1/32	2 5/32	5 13/16	1 31/32	1 29/32	17 1/2
3	3 1/8	2 1/4	6	2	1 15/16	17 7/8

For counterbores from 1½ to 3 inches the following formulas should be used:

$$B = \frac{3A}{4} + \tfrac{7}{8}.$$

$$C = \frac{3A}{4}$$

$$D = \frac{3A}{2} + 1\tfrac{1}{2}.$$

$$E = \frac{A}{3} + 1.$$

$$F = \frac{A}{3} + 15\text{-}16$$

$$G = 3A + 8\tfrac{7}{8}.$$

As will be seen, no dimension has been given in the table for the diameter of the guide, the reason for which is obvious; the dimension for this must, of course, be determined by the size of the hole drilled before counterboring.

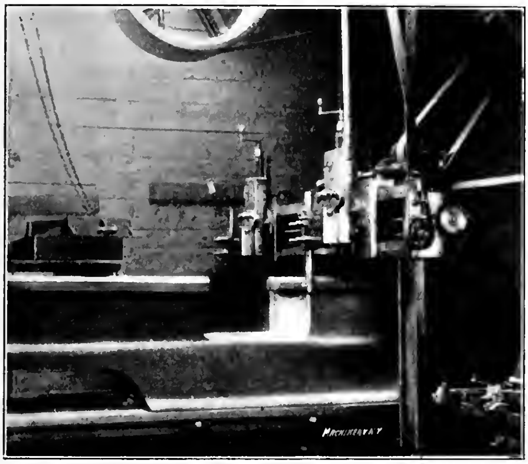
Counterbores are generally made with four flutes. As a rule the flutes are cut spiral, but if counterbores are to be used on brass or cast-iron better results will be obtained by fluting them straight. When milling the flutes in spiral fluted counterbores, the helix should be so selected as to make the lead = 12 × diameter. The angle of the flute with the center line will then amount to about 15 degrees.

New York. A. ANDERSON.

CROSS PLANING A GAP-LATHE BED.

Editor MACHINERY:

We recently had occasion to machine a heavy 38-inch lathe-bed casting 27 feet long, weighing 10,000 pounds, which had a removable section 26 inches long, making a gap in the bed for turning large diameters. The fitting of this gap piece necessitated planing crosswise of the bed. We had been in the habit of planing beds of this description up to 18 feet in length by bolting the casting crosswise of the planer, allowing the long projecting end to travel on a greased parallel support. The extreme length and weight of this casting necessitated some



A Job of Cross Planing.

other expedient. Referring to the accompanying photograph, directly over the crossrail of the planer was placed a friction countershaft having two speeds, a forward and a quick return. This counter shaft was operated by hand by means of a shipper conveniently located. A small pulley was substituted in place of the feed pinion on the cross-feed screw, to take the power from the countershaft. The tool used was the ordinary undercut planer tool. W. L. FAY.

Dexter, Me.

AUTOMATIC SLIDE FORMING PUNCH.

Editor MACHINERY:

The automatic slide forming punch and die shown in the illustration is used to form the tin blank to the shape shown in Fig. 3. As this punch and die is of a rather intricate and elaborate type, and the work produced is of superior quality, a detailed description of its principal working parts may be of interest. The material used is soft tin 0.012 inch thick, the blank being first cut to the required dimensions in the shears by the use of suitable gages and stops. We used this die in a press of the inclinable pattern, thus affording the operator an opportunity to continually feed the blank to the die; the finished work spreads slightly as the punch ascends, and slides off by gravity into a receptacle at the rear.

It may be interesting to note, on referring to the sketches, the means provided for operating the sections which form the work on the sides. It is plainly evident that the slides which make the side bends can be made to move in more or less, to a limited extent, at the will of the operator, by adjusting the studs on the punch that engage the bell-crank levers on the die; these studs, held by check-nuts, are adjustable, having ample range for this purpose.

While the drawing shows only the front view, the same method of construction is employed at the rear, there being in the make-up of the die four studs, *L*, and a like number of bell-crank levers, *D*. Figs. 1 and 2 are front views of the die and punch respectively; Fig. 3 a section and plan of the finished work. In the die, Fig. 1, *A* is the cast-iron base, *B* the tool-steel slides secured on the face of *A* by four shoulder screws, *C*, two of which are shown. Rectangular slots that fit the body of the screws sidewise are provided in the slides to permit them to slide back and forth more than the necessary distance.

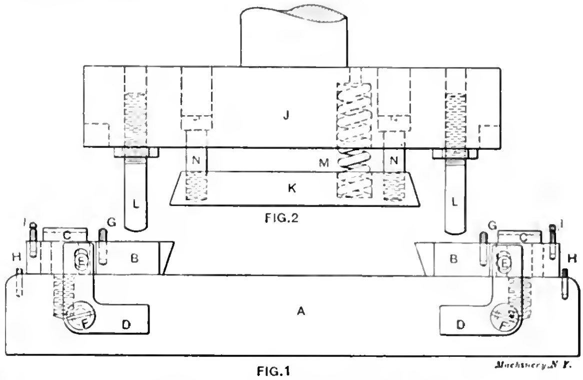


Fig. 1 and 2. A Slide Forming Punch and Die.

The levers, *D*, are pivoted at *F*, and through them the pins, *E*, project, their inner ends having been driven into *B*. These act on the latter when the punch descends and forces the slides in. The pins, *G*, gage the blanks sideways, and *H* check the outward action of the slides. The die, after assembling, was screwed and doweled to a plate of larger dimensions, having pins standing up at the extreme sides, to which springs were hooked extending from the pins, *I*. These were to pull the slides out to their limit on the upward travel of the press ram

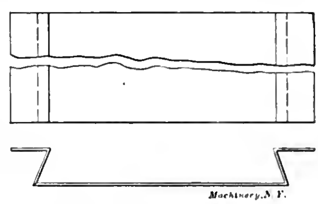


Fig. 3. Product of Die shown in Fig. 1.

The punch, Fig. 2, comprises the holder, *J*, of castiron, form *K*, of tool steel, and the studs, *L*. Part *K* is kept down by eight springs, *M*, arranged conveniently for this purpose, the number being varied according to the stiffness of the blank stock. The former is necessarily fully extended until the punch forces the blank to the bottom of the die, and four screws, *N*, limit its downward projection, one at each corner.

It is not necessary to describe the methods employed in making the various parts of the tool, the machine work being quite clear to any ordinary die-maker. The parts that need the greatest care in making are the former and slides. All sections, with the exception of the body and screws, are hardened, thus increasing the durability of the die. The tool is "subpressed" by means of two 1-inch pins which are fixed in the lower die and are a good sliding fit in the punch holder; for the sake of clearness these pins are omitted from the illustration. C. H. ROWE.

Pittsfield, Mass.

HIGH-SPEED DRILL FOR SPINDLE FORGINGS

Editor MACHINERY:

In drilling spindle forgings, we are often troubled with flaws and seams, some of them being full of sand. To run a twist or water-tube drill through such a spindle is not very satisfactory. In our experience, we would run into such a flaw about ¼ inch, when the drill would stick and break, or turn around with the work, and break off the hose connection. This of course was a little cheaper than breaking the

drill, so we made the connection loose enough for it to slip before the drill would break, but this did not always suffice, and after we had broken a couple of drills on one bad lot of spindle forgings, I went to work and fixed up a drill that the sand would not hurt.

I took a piece of 5-16 inch square "Rex" high-speed steel, the kind that is usually used in tool-holders, and cut it off about 3 inches longer than the piece to be drilled; one end was flattened to the required size, which in this case was 9-16 inch. The cutting lips of the drill were hardened by heating to a cherry red and dipping in coal oil. Care should be taken not to heat the piece too far back, as the oil is likely to get too hot if there is too much steel to be hardened. After grinding the drill to size and notching the cutting edges so as to break up the chips, I was ready to start. This drill did not stick in the flaws or sand cracks, and it cut as fast as any twist or tube drill that we ever used on this kind of steel. Since this experience we have made a good many tools of this kind, and have used them to drill nearly all our tool steel. One of them 11-16 inch diameter, we run 25 inches deep into forgings without any trouble whatever from the chips, or sticking. The spindles we drill are of the regular 50 point carbon steel forgings. C. B.

PLUG AND RING GAGE—DRY VS. LUBRICATED.

Editor MACHINERY:

Does oil take up space? Can a one-inch plug enter a one-inch hole? These two questions the writer has heard argued till every man in the room had his "speil," the result being that at the end of the argument we were no nearer a solution than at the start. A reader of MACHINERY has inquired why it is that a one-inch plug will enter a one-inch ring when properly lubricated, but will not enter when dry. The writer has been asked to offer a solution, but must admit that the question can be better handled by those who are not in the ranks with us "greasy mechanics." The writer has in his possession a plug and ring gage that was made purposely to demonstrate this fact, *i. e.*, when both gages are dry they will not go together without driving, it being impossible to make the plug enter by hand. With ordinary oils as lubricants the plug will start into ring, squeak and lock solid, requiring driving to remove. But with a good heavy lubricant (so heavy in fact that it will float small metal chips), the plug can be easily pushed in and out of the ring by hand. Now, if the surfaces are true and the fit is such that it requires driving, how can oil cover the surfaces and allow the plug to enter at the same time?

Here is one suggestion that may or may not be along the line of solution. First, let us go back a little, for I want to carry the reader along carefully as to the manner in which these gages were made. They were turned nearly to size and hardened; then ground sufficiently to remove the scale. Each gage was then dipped alternately into a kettle of boiling water (until it acquired the temperature of the water, which caused it to expand) then was suddenly immersed into ice water, causing it to contract. This alternate heating and cooling, many times repeated, caused the molecules to twist and change position as various strains were removed. This operation of dipping in hot and cold water was repeated perhaps one hundred times, the result being that the gages were thoroughly settled or "seasoned."

The plug gage was then smoothly ground to within 0.0015 inch of finished size. Then an adjustable cast iron lap and very fine emery paste was used to bring the gage to within "two tenths" of finished size. This lap was then superseded by a new one, perfectly free from emery, and the gage thoroughly cleaned. The emery used for the last "two tenths" was obtained by allowing flour emery to settle in a glass of oil and skimming off the top, using only the emery that floats, which must necessarily be very fine. Bringing a piece of steel to size with emery so fine that it floats will appear to some machinists in the same light that the Indian did to the traveler. The Indian was rubbing away at an old plowshare with a whetstone. The traveler asked him what he was doing. "Ugh! make arrow head." The gage was finished by lapping lengthwise by hand, the lap fitting snugly at all times. When finished, the gage had that peculiar color closely resembling burnished silver.

This pair of gages, remember, was made expressly to demonstrate the difference when lubricated and when dry, and naturally the greatest care was exercised in obtaining a true surface, and under an ordinary glass it was apparently true. But before we lubricate the plug to enter the ring, let us examine it under a Baush & Lomb microscope, magnifying 87 times. The plug gage now appears like a fine rat-tail file. It is my belief that these minute ridges act as tiny reservoirs and carry oil in to the center of the ring where it certainly lubricates, because the plug can then be easily entered in the ring. The fact that expensive chronometer oil, vaseline, lard oils, etc., will not lubricate sufficiently to allow the plug to enter, while a good machine lubricating oil will, should prove a lesson to those who squirt a drop of oil on the end of a finger, smell of it, mutter "lard," and continue to oil up with it. The readers should take up this question and argue it out through the columns of MACHINERY, that we may derive benefits from various minds.

PERPLEXED.

[The question suggested by our correspondent is one that has caused a great deal of perplexity and argument among tool makers and others acquainted with the peculiarities of a "gage fit." It is paradoxical that a plug will enter a ring gage easily when thickly oiled, but will not enter when dry. This condition would apparently indicate that the film of oil occupies no space, or that its presence makes the ring larger, and the plug smaller. It has been suggested that perhaps the oil has a smoothing effect on the surface particles of the gage and plug, similar to that, for example, of the hand on the fur of a cat. Another suggestion is that surfaces brought to the high perfection of finish described by our correspondent, tend to cohere when brought into intimate contact. It has been noted that accurately fitted end gages say ¼ inch square, require an appreciable force to separate them, more in fact, than can be attributed to atmospheric pressure alone. This would seem to indicate that initial cohesion or some other attractive force exists between accurately fitted surfaces, but cohesion means that the surface particles interlock, and this they cannot do in the case of a plug and gage without an extension beyond the normal dimensions. The presence of heavy oil would appear to prevent the engagement of opposing particles, and the heavier the oil the more effective is this interference. Perhaps the heat generated by the friction of the opposing surfaces in the case of a plug and ring when poorly lubricated has a much greater local expansive effect than is commonly suspected. It would seem that there is more involved in this problem than the mere question of mechanical fitting, and that it enters the domain of a complex physical problem.—EDITOR.]

CLOSING A KEYSEAT IN NICKEL STEEL SHAFTS.

Editor MACHINERY:

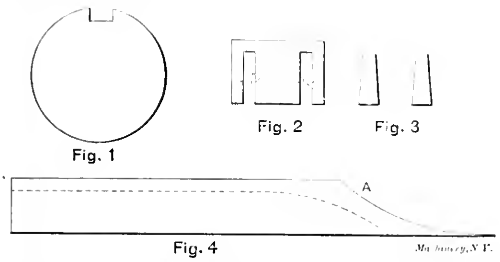
In all shops there are more or less mistakes made, and always will be. It is an established fact that the man who never makes mistakes is, generally, far less profitable to his employer than the man who is able to rectify his mistakes after he has made them, for it is "easy money" that the man who never makes mistakes is the man who has no "go-ahead" of his own. There is almost always some loophole for a man to pull himself out of trouble by if he uses his head, and I would like to show MACHINERY readers how we crawled out of a bad job, in hopes that it may help brother mechanics.

Having twelve large crankshafts to spline in a hurry, the man running the milling machine took his dimensions from another similar shaft, instead of looking up his drawing. This would have been all right had it not been that the sample shaft had the eccentric in place, while the shaft he was splining did not have the eccentric in place as yet. Therefore in allowing for the bearing, he neglected to allow for the eccentric, and consequently the spline was carried four inches into the bearing. As the shafts were nickel steel, you can imagine it was up to us to save them.

At first the foreman refused to allow pieces to be fitted in, and it looked dubious for a while. All kinds of suggestions were made, but he would not hear of tapping and riveting, as

is the common practice, for fear a rivet might work loose and ruin our reputation. On the other hand, I knew that if we lost those shafts, some one was going to lose his job, so after considerable persuasion I got permission to see what I could do, provided I took the responsibility and did not use any rivets. I really think the foreman thought he had me stuck, but as he was anxious to clear himself, he gave his consent.

Placing the shafts upon a vertical milling machine, I squared the end of the spline so that the piece could make a joint. Then with a small dovetail cutter, the sides of the spline were undercut the length of piece to be filled in. Care was taken that the top of the spline was not enlarged any. The end view, Fig. 1, shows how the spline looked after milling. Pieces were milled up from the same kind of stock to fit the top of the spline, which was ¾ inch wide. These pieces were milled to the gage and the end milled as shown at *A*, Fig. 4. Slots were milled 1-16 inch from each edge through the length of the piece to within ¼ inch of the round in the key. These slots were ⅛ inch wide as shown in Fig. 2.



Saving a Spoiled Keyway.

Next I milled small wedge pieces as shown in Fig. 3, using the same cutter to taper the wedges that was used to taper the sides of the spline.

After inserting these two wedge pieces in the key, just hard enough to hold them, without spreading the sides, the piece was pressed into place by means of an arbor press. When the piece was pressed home, the wedge pieces spread the sides of the key to fill the spline in the shaft, making a fit which could never start out, and that without tapping and riveting. After slightly peening the edges of the joint to fill any cracks, the shaft and key were turned off in a lathe, and when ground it was impossible to detect it. Before carrying out this idea, a sample spline was tried, and after pressing home, it was attacked with hammer and chisel to see if it could be started. The piece had to be literally chipped out, and not until about two-thirds of the key was removed could the joint be started. TEXAS.

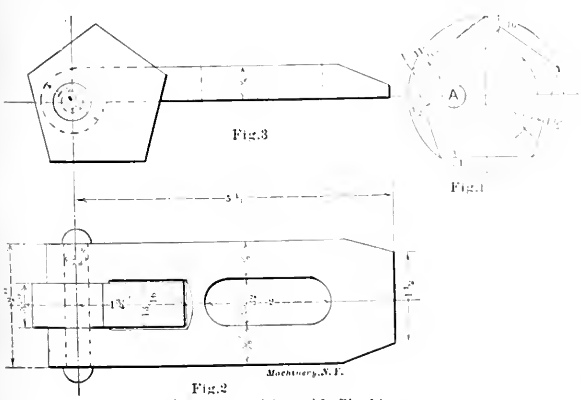
CLAMP WITH CHANGEABLE HEIGHT BLOCKING.

Editor MACHINERY:

Enclosed you will find a sketch which illustrates a changeable clamp device. The idea for this design I got in a machine shop where electric motors are built. To bore out the frames, they are set with their legs on the table of the boring machine and common clamps are used to fasten them up. Of course, as the motors are of different sizes, a whole pile of shimming and old nuts are required to put under the clamp. To avoid this I have the following idea: In a circle of 2½ inches diameter draw a regular pentagon with the base parallel to the diameter of the circumscribed circle as shown in Fig. 1. The left portion of the horizontal line from the center point to the outside of the pentagon is divided into two equal parts, the center being at *A*. From point *A* draw a line perpendicular to each side of the pentagon. By doing this we get five different positions of ½, 11-16, 1, 1 5-16, and 1½ inch. Suppose we have such a pentagon as described above made of cast-iron, say ¾ inch thick, and bring this in connection with a clamp, as shown in Figs. 2 and 3 by means of a rivet so that we can turn the pentagon. In this manner we get a handy tool very useful and practicable for lathes, planers, shapers, boring and milling machines, drill presses, etc. A pile of old nuts and blocks is not necessary any more. I suggest the use of a rivet for connection, to avoid separation. Fig. 3 shows the side view of the clamp. Three or four of these clamps will be enough for any kind of work in every shop. They are easy and cheap to manufacture and worth trying. MAX DEHNE.

Dayton, Ohio.

[A clamp on this principle was patented some years ago and, we believe, has been used to some extent.—EDITOR.]

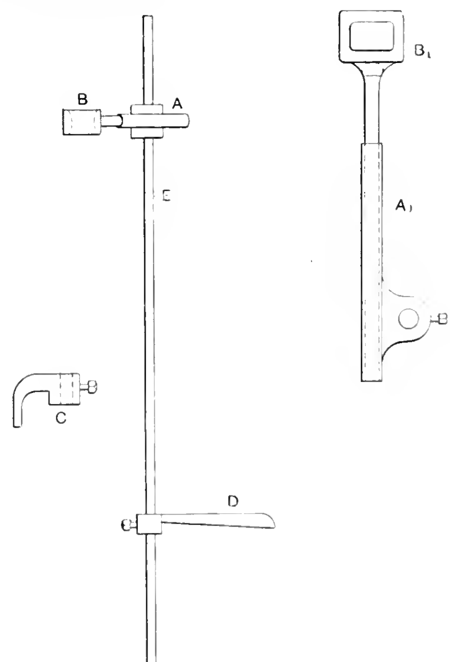


Clamp with Adjustable Blocking

A HANDY BELT SHIFTER.

Editor MACHINERY:

The sketch shows a belt shifter which is as handy as anything going in its own line, for any belt running on cone pulleys, and especially for the lathe on account of the lathe belt having to be shifted often.



A Cone Pulley Belt Shifter

This device is far ahead of having to use a stick, which is usually kept hanging on some convenient post. In using the stick the operator leaves his machine and goes where the shifting stick is kept, carries the stick to the machine, shifts the belt, then carries the stick back to its place. With the device here shown, the operator simply has to reach the projecting handle, give it a push and the belt slips off the upper cone and is quickly shifted to the corresponding cone on the lower pulley by hand. In shifting the belt the other way, the belt is first pushed off the lower pulley by hand and instantly shifted to the corresponding cone on the upper pulley by a pull of the handle on the shifter. The belt can be shifted

the whole length of the cone pulley by simply turning the handle far enough either way. Two stops fastened to the upright rod prevent the belt from being shifted off the pulley.

Referring to the sketch, A is a casting with a hole clear through the long part and a key-way milled through the side from near the base to within a short distance from the other end. The boss is bored to fit the rod E and a setscrew is fitted to hold it in place. B is the belt-guide, having a stem which fits loosely into A, and a pin driven in one side to act as a key to slide in the keyway in A. The belt-guide is riveted loosely to its stem to allow for sideplay. The reason for having the stem fit loosely in A is to allow adjustment to B for following the belt as it is shifted. At A_1 and B_1 is an enlarged sketch of A and B for a better understanding of it. C is a stop which is bored to fit the rod E and fitted with a setscrew for fastening. There are two pieces like C, placed one above the other on the rod E and fastened so that one or the other will bring up against the upper support for the rod E, when the belt is either on the largest or the smallest cone of the pulley. These stops of course are to prevent the belt slipping off the pulley. D is a handle bored to fit the rod E and fitted with a setscrew for fastening. The handle is either pulled or pushed to shift the belt. E is either a solid or hollow rod pivoted to the machine at the bottom and to the ceiling at the top in a manner best suited for the machine. It must be free to turn around as the belt shifts, and yet not too loose.

C. J. S.

TABLE OF MODULI OF CIRCULAR SECTIONS.

Editor MACHINERY:

In figuring the strength of pins and shafts for bending, it is necessary to know the modulus of the section. To facilitate such calculations, the accompanying table has been prepared. The formula $\pi d^3 \div 32$, the modulus of a circular section, was worked through for the following diameters: 1-32 inch to 6 inches, varying by 1-32 inch; 6 inches to 9 inches, varying by 1-16 inch; 9 inches to 11⅞ inches, varying by ⅛ inch, and the results were tabulated. "Vega," seven-place logarithm tables were used.

Example: It is desired to find the diameter of a projecting circular shaft to support a load of 5,000 pounds, 12 inches from the point of support. The allowable fiber stress for steel being assumed as 15,000 pounds, and using the formula $M = f s$, we have:

M = bending moment in inch-pounds.

s = modulus of section.

f = allowable fiber stress.

$$M = 5{,}000 \times 12 = 60{,}000 \text{ inch-pounds,}$$

$$60{,}000 = 15{,}000 \times s,$$

$$s = \frac{60{,}000}{15{,}000} = 4.$$

Looking in the table for the modulus 4, we find that the nearest number to 4 is 3.9887, which is the modulus of a section 3 7-16 inches in diameter. The size shaft to use would therefore be 3 7-16 inches.

O. E. THALEG.

So. Milwaukee, Wis.

MODULI OF CIRCULAR SECTIONS.

$$\frac{\pi D^3}{3'} = .0982\,D^3$$

Dia.	0	1	2	3	4	5	6	7	8	9	10	11
0	0	.0982	.78560	2.6507	6.2848	12.2750	21.2112	33.682	50.279	71.918	98.20	130.70
1/32	.0000029	.10768	.82294	2.7350	6.4330	12.5066	......	......	......	......	......	......
1/16	.0000239	.11779	.86157	2.8205	6.5840	12.7411	21.8809	34.593	51.464	......	......	......
3/32	.0000809	.12554	.90127	2.9077	6.7360	12.9775	......	......	......	......	......	......
1/8	.0001918	.13981	.94229	2.9968	6.8910	13.2188	22.5647	35.519	52.672	74.612	101.92	135.21
5/32	.000374	.15178	.98441	3.0875	7.0502	13.4621		......	......	......	......	......
3/16	.000647	.16069	1.0279	3.1803	7.2106	13.7083	23.2625	36.462	53.897	......	......	......
7/32	.001028	.17775	1.0725	3.2745	7.3730	13.9576	......	......	......	......	......	......
1/4	.001534	.19179	1.1185	3.3710	7.5384	14.2098	23.974	37.422	55.141	77.720	105.50	139.82
9/32	.002184	.20652	1.1657	3.4690	7.7056	14.4651	......	......	......	......	......	......
5/16	.002996	.22202	1.2143	3.5692	7.8758	14.7234	24.701	38.398	56.403	......	......	......
11/32	.003988	.23824	1.2642	3.6711	8.0481	14.9847	......	......	......	......	......	......
3/8	.005178	.25528	1.3165	3.7751	8.2233	15.2492	25.442	39.391	57.685	80.914	109.65	144.53
13/32	.006584	.27305	1.3680	3.8808	8.4198	15.5167	......	......	......	......	......	......
7/16	.008223	.29477	1.4221	3.9887	8.5808	15.7873	26.197	40.401	58.987	......	......	......
15/32	.0101140	.31110	1.4774	4.0984	8.7630	16.0610	......	......	......	......	......	......
1/2	.01227	.33142	1.5343	4.2103	8.9485	16.3380	26.968	41.428	60.307	84.194	113.67	149.35
17/32	.014734	.35259	1.5955	4.3200	9.1359	16.6181	......	......	......	......	......	......
9/16	.017477	.37460	1.6523	4.3399	9.2837	16.9017	27.753	42.472	61.647	......	......	......
19/32	.020555	.39742	1.7134	4.5576	9.5191	17.1878	......	......	......	......	......	......
5/8	.023975	.42137	1.7762	4.6777	9.7151	17.4774	28.554	43.552	63.021	87.561	117.78	154.28
21/32	.027766	.44611	1.8403	4.7996	9.9130	17.7295	......	......	......	....	......	......
11/16	.031920	.47189	1.9061	4.9239	10.114	18.0665	29.370	44.613	64.386	......	......	......
23/32	.036462	.49856	1.9733	5 0499	10.313	18.3660	......	......	......	......	......	......
3/4	.041428	.52629	2.0422	5.1785	10.524	18.6683	30.201	45.710	65.786	91.017	121.99	159.30
25/32	.046826	.55494	2.1125	5.3088	10.733	18.9757	......	......	......		......	......
13/16	.052672	.58471	2.2355	5.4418	10.945	19.2841	30.976	46.815	67.206	......	......	......
27/32	.058986	.61544	2.2582	5.5765	11.159	19.5968	......	......	......	......	......	......
7/8	.065786	.64731	2.3346	5.7138	11.3771	19.9129	31.910	47.958	68.646	94.563	126.29	164 44
29/32	.073089	.68017	2.4104	5.8529	11.5973	20.2323	......	......	......	......	......	......
15/16	.080914	.71422	2.4891	5.9948	11.8205	20.5552	32.788	49.109	70.106	......	......	......
31/32	.089278	.74929	2.5693	6.1384	12.0462	20.8815	.....	......		......	......	......

MECHANICAL ADVERTISING.

Editor MACHINERY:

The man who said that the superlative degree was invented for advertisers spoke somewhere near the truth. While no doubt in the best advertisements moderation is practised, many appear in which there is so much straining after "going one better than the other fellow" as to become absolutely impossible. Indeed, it often becomes a question whether the "ad" shows the writer's ignorance or his knowledge of other people's. For instance, a British copper wire manufacturer announces that his cable has 100 per cent conductivity. Now I do not know much about things electrical, but a cable is, theoretically, a machine and you cannot get out of it as much as you put in. Another English firm sells "frictionless engine packing." The quotation marks are mine. That these things are absurd ought to be obvious to anyone in the position to have any say in the matter of buying them. Why, then, are they made a point of in the advertisements?

To successfully advertise is no easy matter. The "ad" should be so compiled that men interested in such things look for it, one might almost say, habitually. The attracting of the eye is generally more, I take it, the printer's work than the compiler's of the ad; a big headline, or perhaps the reverse, a small amount of matter in a large space, a taking photo, all tend to attract. To hold the attention when once attracted the matter must be interesting. In this the me-

chanical advertiser has some little advantage; a man advertising, say, a patent medicine has to create an interest in his wares, but the compiler of a mechanical "ad" has generally the interest there—he needs only to stimulate it.

In conclusion, if I were writing a book on advertising I think I should lay down as a postulate that the art of "ad" writing does not consist of packing as many superlatives to the square inch as is possible. McAnic.

AN ADJUSTABLE DIE—AN ANGLE CUT-OFF DIE

J. L. Lucas.

Editor Machinery:

We had a large number of contact pieces for electrical work to be cut from pure silver, and it was important not to waste the stock more than was absolutely necessary. At first we cut them out with hand shears, but the number wanted was so large, and the process was so slow, that a die like the sketch was made for the work. The operation of the same was so satisfactory that I think it will be interesting to those engaged in electrical work. It is so simple, an explanation is hardly necessary.

The gage *A* is set to the width you want and the stop *B* is set to the length of the piece wanted, and then in feeding, the work is held against the back gage and pressed up to the stop. The sizes that can be cut are only limited by the size of the die. The punch is cut out as shown to allow the stop to project up so the silver will strike it. Both punch and dies are hardened in the usual manner.

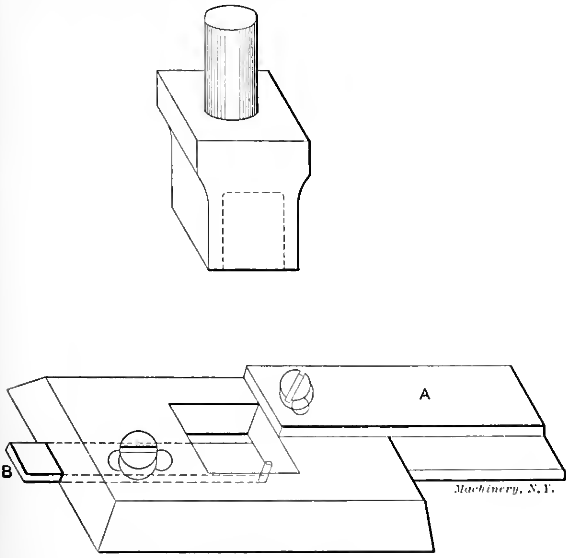


Fig. 1. A Die for Cutting Silver Blanks without Waste.

In cutting off angle iron for automobile frames, or other work of that nature, it is desirable to have both ends of the work left square, which an ordinary angle iron cutter will not do.

The punch and die shown were made to overcome this defect, and they do it very satisfactorily. They leave a nice true surface on both ends of the piece cut off. There is only one objection to the use of the die, and that is, there is one-quarter inch waste on every cut, or whatever may be the thickness of the punch.

The punch shown is made at an angle of forty-five degrees, so as to give a shearing cut.

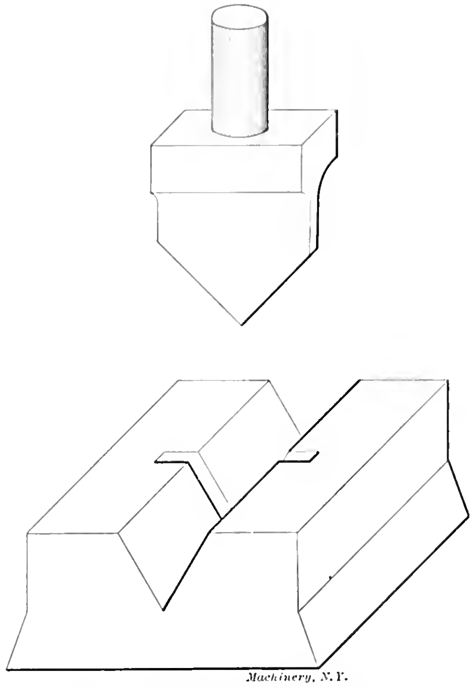


Fig. 2. Punch and Die for Cutting Angle Iron.

The time spent on the die in making, was twenty-two hours, and it has paid for itself many times over. It takes in all sizes from one to three inches, and works equally well when there is a long and short leg to the iron. J. L. Lucas.

Bridgeport, Conn.

James L. Lucas was born at North Carver, Mass., 1855. He served an apprenticeship with E. T. Jenks, Middleboro, Mass., and has since worked for the Mason Machine Works, General Electric Co., Domestic Needle Co., and Mossberg & Granville Co., in the various capacities of toolmaker, foreman, draftsman, salesman and superintendent. His specialty is dies and press tools, and he has written a book on the subject, called "Dies and Die Making," which has had a considerable sale. Mr. Lucas has contributed frequently to the trade papers, generally under the nom-de-plume of "A. P. Press."

SHELL COUNTERBORING TOOL.

Editor Machinery:

The piece of work shown in Fig. 2 is the clutch hub of an automobile, and it is a bronze casting. A helical spring, made of 5-16 inch square stock, is required to work smoothly in the recess *A*.

It was first tried to cast this recess, but there always were fins left at the bottom that had to be chipped out, and the sides were so rough that the spring would not work smoothly.

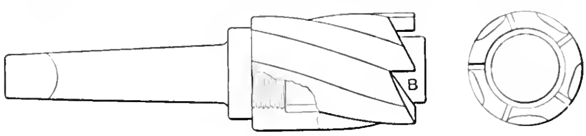


Fig. 1. Shell Counterboring Tool.

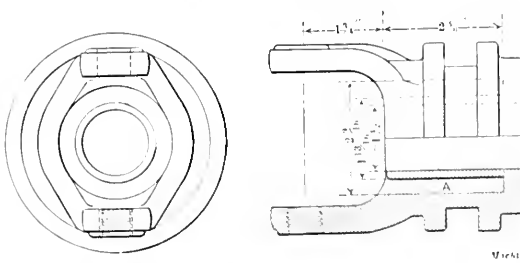


Fig. 2. Showing Cut taken by Shell Counterbore.

It was then attempted to clean out the recess in a lathe, using a tool similar to a cut-off tool, but having a blade bent in an arc. The tool was necessarily long and springy. The lathe hand succeeded in doing about twenty pieces before it broke. Another tool was made, which lasted about as long as the first. Then the tool shown in Fig. 1 was constructed, and has proven quite successful.

It consists of two pieces, being a tool steel shell, screwed upon a machinery steel shank. The shank is tapered to fit the tailstock of a lathe, and extends through the shell so as

to form a pilot, which enters the 1½ inch reamed hole shown in Fig. 2. The shell has five cutting teeth, and five spiral flutes to carry away the chips. The tops of the flutes are relieved like the flutes of a twist drill. The inside diameter of the shell is 1-64 inch larger at the back than at the cutting edge, and the outside diameter is 0.005 inch less at the back than at the front.

The work at present is being done in an engine lathe, the casting being chucked, the 1½ inch hole bored and reamed, and the recess bored with the above tool. The work is then taken from the chuck and finished on a mandrel.

Indianapolis, Ind. OTTO L. LEWIS.

GRINDING EIGHT-INCH FINISHING ROLLS.

Editor MACHINERY:

Permit me to present a method of grinding eight-inch steel rolls by means of a lathe fixture which has been found to be both effective and successful. In the accompanying sketch, *A* is the roll to be ground; *B* represents two cast iron bearing blocks with two steel studs *C* driven into each and threaded on the extending part. The cast-iron brackets *D* are offset in order to allow full travel for the carriage on the lathe bed. In order to dispense with vibration, these castings are made particularly stiff and strong, the offset parts being heavy and joined by stout stiffening ribs. On the top of each bracket where the bearing block *B* rests are two slotted holes into which studs *C* fit, being fastened on the under side of the shelf by means of nuts. These holes give all necessary adjustment in setting the rolls. The brackets are gripped on the lathe-bed by clamps consisting of wrought-iron straps *E* with two bolts *F* through each strap.

This fixture is placed on the inside ways of the lathe bed while the carriage travels on the outside ways. The emery wheel is driven by a motor attached to it, both the motor and wheel being placed in the toolpost of the lathe. The cooling water runs down over the top of the roll from a tube connected

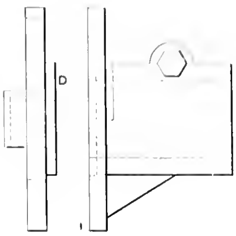


Fig. 1.

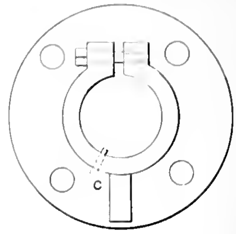


Fig. 4.

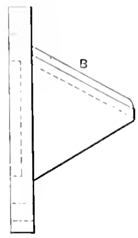


Fig. 2.

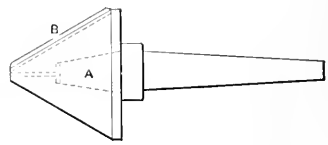


Fig. 3.

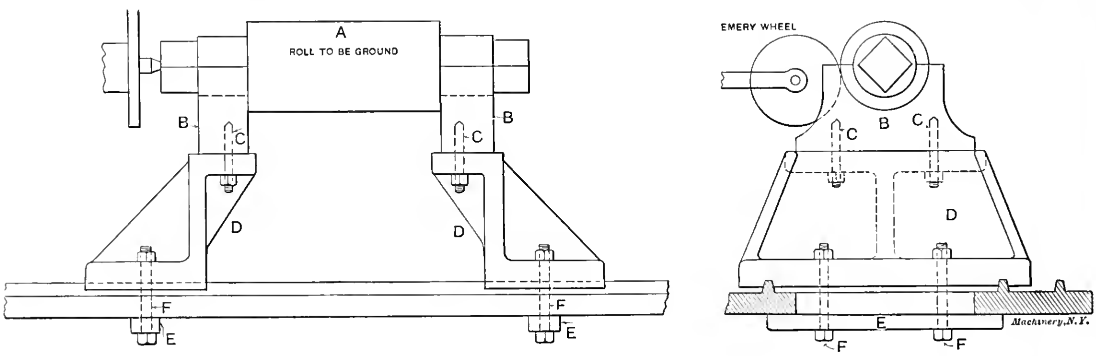
Machinery, N.Y.

Lathe Attachments for Machining Bushings.

and ground. The part *A*, on which the center turns, is made taper to insure it remaining tight and true when it begins to wear.

The core of the bush casting is then centered at each end with a large center reamer, and a small slot chipped in each end to clear the keys *B B*. A 1¼-inch key projecting ⅛ inch has been found sufficient to drive the heaviest cut, and a much smaller key will do all right in Fig. 3.

When the bushes have been turned to size on these centers



Rig for Grinding Rolls.

to any convenient receptacle. The wires which bring the supply of current are connected to the motor on the toolpost, the power for the lathe being a separate consideration. This grinding arrangement, simple in detail and easy to set up and adjust, insures full travel for the grinding wheel over the surface being finished and moreover performs the work rapidly and accurately. W. T. M.

Providence, R. I.

METHOD OF MACHINING BUSHES.

Editor MACHINERY:

The following is a method which we have found very satisfactory for turning out brass and babbitt bushes in large quantities at a minimum cost. The quality of the work produced is very accurate.

We have a large number of bushes to make, a good many of them of the same diameter, but of different lengths, so we make all our castings about 10 or 12 inches long. To save truing up, we have found it economical to make a special faceplate with a shoulder on it, as shown at *D*, Fig. 1. To this we clamp the cast-iron center, Fig. 2, and in the place of the tail center we put another style of center, Fig. 3. This tail center is made of cast iron and the spindle of tool steel, hardened

we remove the head center and in its place clamp the chuck, Fig. 4. This chuck was bored the exact size of the bush on this same faceplate with the clamp bolt tightened slightly, so that when the bolt is loosened the bush slips in easily, and when tightened again is absolutely true. The slot has been found necessary to make this chuck clamp the work parallel with the center line. The bushes are then cut off and bored out in this chuck. In case the bushes have to be correct for length, we put a pin, *C*, in the side of the chuck for a stop, and face the end of the chuck the correct distance from the pin. All that is then necessary is to slip the bush in against the pin and set the tool by the end of the chuck for the finishing cut.

We have found this method to be a time-saver where there are a large number of bushes to make.

Amherst, N. S. S. J. FISHER.

* * *

The Pennsylvania Railroad Co. has placed the largest equipment order in this country. The order consists of 500 locomotives and 15,000 freight cars; 250 of the locomotives are to be built by the Baldwin Locomotive Works, and 250 by the company's shops at Juniata, Pa. The value of the locomotive order is $7,250,000 and of the cars $15,000,000.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO ANNEAL HIGH-SPEED STEEL.

High-speed steels may be very thoroughly annealed by packing in a cast-iron box in gray cast-iron chips. The steel should be surrounded by an inch or two of the chips. Then heat slowly in the gas furnace (or a blacksmith's forge will do) to a cherry red. Hold the heat there for from one to three hours, according to the size of the pieces to be annealed, cover the box well and allow to cool slowly—in the gas furnace if possible.

I. W. ANTANO.

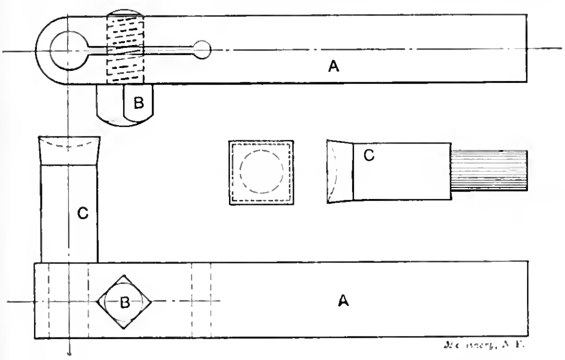
TO HARDEN SMALL JIG BUSHINGS.

To harden large quantities of small jig bushings without danger of cracking under the head while hardening or while driving them home, proceed as follows: Put one gallon of fish oil in a suitable metal bucket and place in a larger bucket of cold water. The bushings, strung about six on a wire, are heated in a small blow torch fire to a light red heat and are then quickly plunged into the oil, and kept moving around until cold. The hardness will depend upon the degree of heat given, and this can be so regulated that it will not be necessary to polish and draw bushings after hardening.

New York. H. J. BACHMANN.

SHAPER TOOL FOR SQUARE AND OBLONG HOLES.

I am sending you a sketch of a shaper tool for working out square and oblong holes at one setting. As shown at *C*, the tool cuts on the end, has relief at all four sides, and is cupped out at the center to allow the chip to curl. The other end is



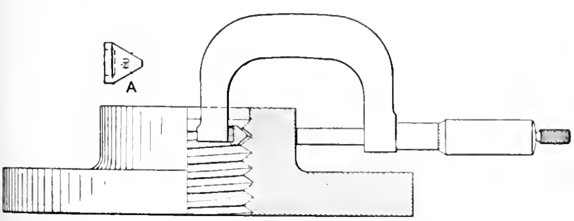
turned down to fit the hole in the shank, *A*. This shank is split as shown in the top view, so a wrench applied to the screw, *B*, will hold the tool firmly in place. When in use, the clapper of the tool head is wedged down.

St. Paul, Minn. ARTHUR MUNCH.

USE OF MICROMETER FOR INTERNAL THREAD CUTTING.

Editor MACHINERY:

The accompanying sketch illustrates a means of determining the threaded size of duplicate work. The plate shown is intended for a lathe chuck. The outside diameter of the hub



on this plate is turned to the same size as the hubs on small faceplates which are furnished with all new lathes. The threaded size is then taken and transferred with a micrometer, over the anvil of which is fitted a 60-degree point as shown enlarged at *A*. In connection with a graduated cross-feed screw this greatly facilitates the work over the usual cut-and-try method.

Detroit, Mich. CHARLES SHERMAN.

LINING UP LATHE CENTERS.

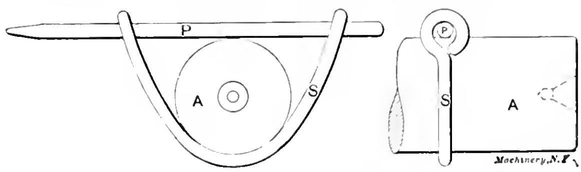
To line up the lathe centers to turn straight, turn up about an inch on the end of a small piece, say about 2 feet long, being careful to make it perfectly round. Put a tool in the tool-post with the blunt end of the tool next to the work and have the end of the tool free from burrs. Turn the bar end for end, having the turned end at the live center. Now run the tool up against the finished part of the bar, taking care to come in contact with the piece carefully. Make a light scratch with a scriber on both the cross-slide handle and the sleeve in which the cross-slide screw runs. Next draw back the tool from the work and turn the piece around so the turned part is at the tail center, then run the carriage up and feed the tool up and adjust the screws in the tail-stock until the marks made by the scriber on the cross-slide handle and sleeve come in line, with the tool lightly against the work.

Detroit, Mich. C. J. SHAW.

SPRING FASTENER FOR LATHE POINTER.

Editor MACHINERY:

The accompanying sketch of a feeler or pointer shows one that is used for setting up work in a lathe where the work has a hole through it, and is to be trued up by the hole. An arbor *A* is placed between the lathe centers, and the spring *S*, which is a straight piece of spring wire with an eye formed at each end, is sprung around the arbor and the pointer *P* passed through the eyes and over the arbor, making tension



enough to hold the pointer in place. The arbor is rotated by hand and carries the pointer around with it to test the accuracy of the setting. This device is of the most service for heavy and awkward-shaped pieces, as they can be set and fastened without starting the lathe. It is also very handy for setting on the lathe carriage cylinders, bushings, etc., that are to be bored with a boring bar. A very light arbor can be used together with a short spring and pointer when the hole in the work is small. With the end of the pointer bent hoop-shaped it can be used for setting to the outside of a hub.

Watervliet, N. Y. M. H. BALL.

* * *

The publication of the Rand Drill Co., known as *Air Power*, issued under the direction of Mr. P. F. Kobbe, is discontinued with the October issue. Although it had been published quarterly for only one year it had come to be recognized as one of the best class of house-organ publications. The combination of the Rand Drill Co. with the Ingersoll-Sergeant Co. under the name of Ingersoll-Rand Co. made the publication of *Air Power* unnecessary as the older publication, *Compressed Air*, issued by the Ingersoll-Sergeant Co., will be continued.

* * *

A correspondent sends us an advertisement of a washing machine which he has clipped from a farm paper. It contains an interesting description of the manner in which the springs and ball bearings in the aforesaid machine do practically all the hard work that usually falls to the housewife's lot on Monday morning. To quote from the advertisement, "In using this machine a *little* help is needed from you each time, but the springs and the ball bearings do nearly all of the hard work." We cannot but wonder why the inventor did not add a few more springs and ball bearings so that they might do all of the work, perhaps even to the extent of making a brake a necessary part of the machine to prevent the mechanism from running away.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

102. TO IMITATE CASEHARDENING.

Occasionally it becomes necessary to darken polished or ground parts to imitate casehardening; in order to accomplish this result use this mixture: 1 part nitric acid and 20 parts water. Immerse the article to be treated about 20 seconds, then rinse with clear water. A splendid result can be accomplished by following the above instructions. HARRY ASH.

Chicago, Ill.

103. BRIGHT DIP FOR BRASS, COPPER AND BRONZE.

A bright dip for brass, copper and bronze may be produced as follows: Make a solution of 100 parts by weight of nitric acid, 50 parts sulphuric acid, 1 part soot, and 1 part salt. The salt and soot make the dip work smoothly. The article should be dipped in this solution, well washed, and dried in sawdust to prevent streaking. S. H. SWEET.

Bridgeport, Conn.

104. PACKING FOR GAS ENGINE CYLINDERS AND PIPE CARRYING GASOLINE VAPOR.

To prepare packing for joints in pipes, etc., carrying gasoline vapor, mix a quantity of graphite and kerosene to a thick paste and apply the paste to both sides of sheet asbestos. When dry the packing may be cut to the shape desired. The graphite helps the asbestos make intimate contact with the iron and thus maintain a tight joint continuously at high temperature for an indefinite time.

New York. H. J. BACHMANN.

105. BRASSING IRON.

Iron ornaments are covered with copper or brass, by properly preparing the surface so as to remove all organic matter which would prevent adhesion, and then plunging them into melted brass, or copper. A thin coating is thus spread over the iron, and it admits of being polished, or burnished. The better the article is finished and cleaned before dipping, the better will be the final result. R. B. CASEY,

Schenectady, N. Y.

106. COMPOUND FOR CLEANING THE HANDS.

To loosen the oil and grease, the hands should first be scrubbed with a stiff brush dipped in kerosene, and then they should be wiped dry with waste. Take a five-cent box of any kind of soap powder (I prefer Soapine, because it lathers freely) add to it an equal quantity of sawdust and half the quantity of white sand. Mix thoroughly and rub over the wet hands in the form of a paste. This entire mess will rinse off in any kind of hard or soft, hot or cold water. Hands washed in this manner twice a day will be free from grime and clean all over. H. J. BACHMANN.

New York.

107. CEMENT FOR STICKING EMERY PAPER ON SMALL GRINDER DISKS.

Melt together 5 parts paraffine, 4 parts bees' wax and 1 part rosin. When cold, cut into blocks, and apply evenly on the revolving disk until it has a thin coat over its entire surface. The emery paper should then be pressed on the disk while it is still revolving, thereby slightly heating both the disk and the paper, and causing the cement to spread in a thin layer all around the disk. The belt should then be shifted onto the loose pulley, so that the paper may be pressed closely to the disk. The corners may then be trimmed off with an old file. It requires a little practice to perform the job successfully, but the method is much superior to removing the disk and gluing the emery paper on in a press. The worn-out paper can be more easily removed, it being only necessary to wait until the disk is cool, when, by taking hold of one portion of the paper, it may be ripped right off.

New York. H. J. BACHMANN.

108. CEMENTS FOR IRON JOINTS.

The following are cements used to make the joints of machinery air and water tight:

1. Mix ground white lead with one-fourth its weight of red lead.

2. Mix equal parts of red lead and white lead, in powdered form, with enough boiled linseed oil to make the whole a soft, putty-like mass.

3. To 50 pounds of borings, preferably cast iron, which have been pounded and sifted, add one pound of sal-ammoniac. Mix with water when ready to use.

4. Boiled linseed oil and red lead mixed to the consistency required. A small quantity of litharge improves the cement for many purposes.

5. Cast iron borings, 4 pounds, dried potter's clay 1 pound, powdered potsherds (broken crockery) 1 pound. Make into a paste with salt and water.

I have used all of these cements and find them satisfactory No. 3 is used largely for filling cracks in boilers, etc., and No. 5 is excellent for outdoor iron work, water tanks, etc.

New Britain, Conn. F. L. ENGEL.

109. TO TREAT INFLAMED EYES—CARE OF THE EYES.

The treatment of an inflamed eye is a matter of some moment in a machine shop and too much care cannot be taken to treat such cases scientifically. You have only two eyes—unless you are a foreman and then you are supposed to be a full-fledged pineapple, as far as eyes are concerned. A splendid remedy for an inflamed optic is a weak solution of powdered borax water—either warm or cold—applied by rubbing it in the eye with a cloth, or dropping it in. It is very soothing and will drive the soreness and inflammation out and leave the eye in a better condition than it was before it was irritated. The proper proportion is a spoonful of powdered borax to a glass of water. A mechanic should always bear in mind that the loss of an eye may drive him to selling shoe-strings. A pair of plain eyeglasses will protect the eyes from chips or emery, and borax water is good for tired eyes too—the kind of eyes you have when working too much overtime.

Another eye kink is to get a round looking glass about 3 inches in diameter, and on the back of it near the center attach a cloth band or strap. I made one with a ball-and-socket joint. Now this strap is made to fit easily around the head, the glass resting against the forehead. The function of this glass is to reflect the light from a distant window on to the work. It is a very satisfactory rig to wear when filing to a line or working to a line on a machine. The finer the glass the better is the focus of light reflected. By using a ball-and-socket joint the glass can be instantly adjusted to throw the light on the point you wish to see. Every diemaker ought to have one. CARROLL ASHLEY.

Rochester, N. Y.

* * *

The place that scraping fills in the fitting and finish of modern machine tools is not, in the best practice, that of making the working surfaces more accurate, but of giving them smoothness and hardness that approximates the well-known condition of a worn cast iron surface. The mistaken estimate of scraping was that it is done to enhance accuracy. This was true, and is still true to a certain extent for small surfaces, but it is largely untrue when it comes to the matter of scraping on housing faces and other parts which have a great superficial area. It is manifestly impractical for a fitter to scrape down a large area any perceptible amount. The planer hand must be held to strict accountability, and if the work produced by his machine does not show truth within a very few thousandths it must be replaned, rather than scraped. And even if it were practicable to reduce large surfaces, the scraping process is more or less unreliable for it is dependent upon a system of straight-edges and surface plates which require great care if they maintain their truth, and in the large sizes are very difficult to handle without distortion. The place to secure accuracy is on the planer; the scraping should be done to improve the surface qualities and thus reduce wear and friction.

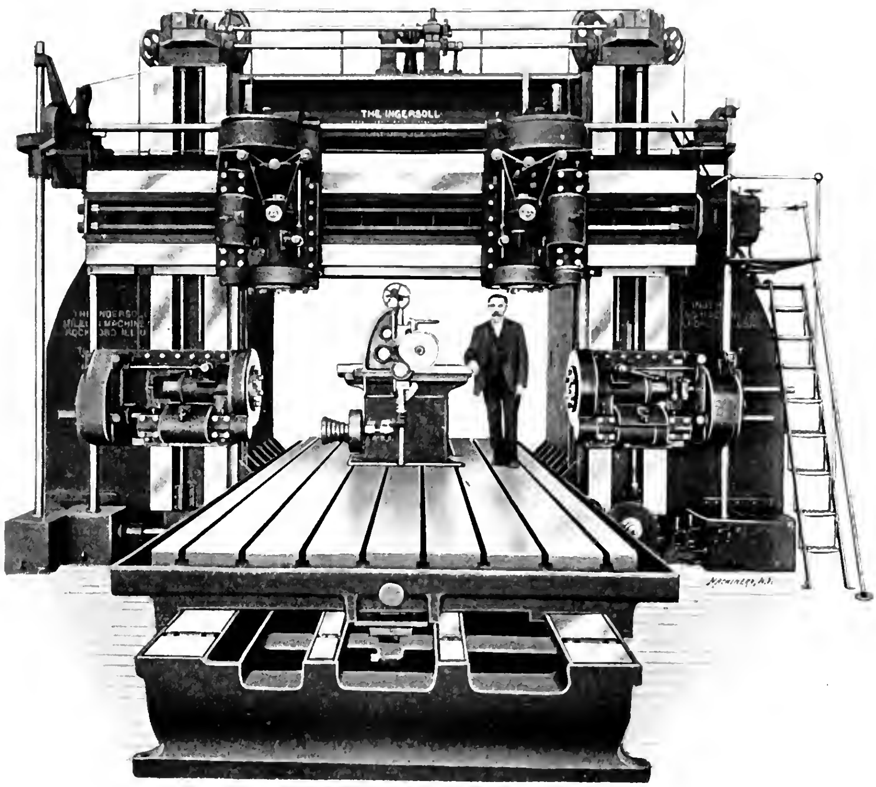
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

HEAVY FOUR-SPINDLE MILLING MACHINE.

The Ingersoll Milling Machine Co., of Rockford, Ill., have recently built the milling machine shown in the accompanying cut. It is of unusually large size and was built for the General Electric Co., Schenectady, N. Y. It is possible to get some notion of its capacity by comparing it with the smaller machine, one of the first lot built by the firm. This new machine is of the planer type with two vertical heads on the cross rail and two horizontal heads on the housings. The saddles are all of the same type. The large face mills which are used, are mounted on face plates driven by gear teeth cut in their periphery. The cutters in each saddle have independent adjustment, that is, the vertical saddles have adjustment vertically and the horizontal saddles have adjustment horizontally, 8 inches in each case. The right hand vertical and horizontal saddles each carry auxiliary spindles for small face mills. The two spindles on the cross rail have independent reversible cross feed and the right hand horizontal spindle has independent up and down feed. Both horizontal saddles, the cross rail, and the two vertical spindles are raised and lowered by power and are counterbalanced. The machine is driven by four motors, one of 50 horse power, which drives the two horizontal heads, one of 50 horse power for the two vertical heads, one of 15 horse power for the table feed, and one of 5 horse power for raising and lowering crossrails; these are all General Electric variable speed motors. The spindle drives and feeds are thus independent of each other.

The housings are braced by heavy buttresses to take the side thrust necessary to carry a big face mill along the crossrail, under the pressure of a heavy cut. This entails considerable strain, especially if the cross rail is near the top of the housing. The machine will take a casting 10 feet high and 10 feet wide. The table is 20 feet long within the pockets, 108 inches wide over all, and has four bearings, two near the outside edge of the table and two supplementary ones near the center. The shipping weight of the machine was 300,000 pounds.



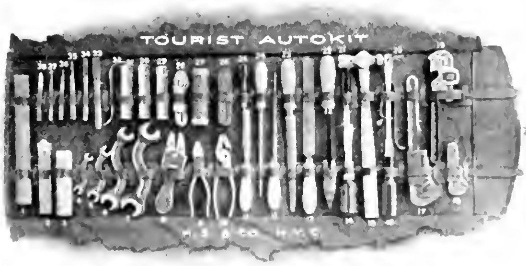
Ingersoll Four-spindle Milling Machine. The small Milling Machine on the Plateu is the first one Built by the Company, in 1887.

TOURIST AUTO KIT.

The kit of tools shown in the cut is designed, as its name implies, for the use of automobilists in repairing breakdowns on the road. Most of the tools are plainly shown in the drawing, yet there may be a few whose use is not apparent.

No. 1 is a roll of emery cloth, containing three different grades.

No. 3 is a soldering stick.



Tourist Auto Kit

No. 20 is a chain holder for connecting or disconnecting chains while on the road.

No. 26 is a roll of adhesive tape.

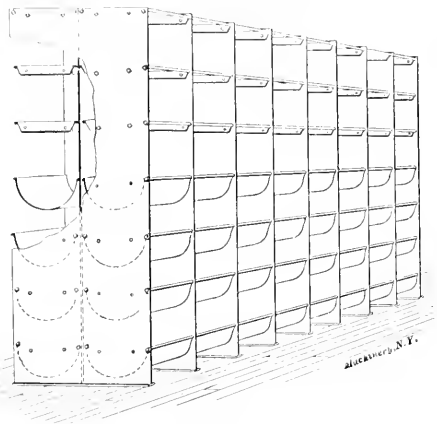
The three nickel-plated cases, Nos. 29, 30 and 31, contain a gasoline hydrometer, a supply of emery for grinding valve seats, and an assortment of cotter pins of various sizes.

No. 32 is a cotter pin extractor.

The whole outfit rolls up into a compact canvas case; it is sold by Hammacher, Schlemmer & Co., New York, N. Y.

THE ECONOMY STEEL BIN.

This bin, of which a line engraving is shown below, is built by the Davis Mfg. Co., of Milwaukee, Wis. The frame is made of 16-gage and the bins of 26-gage sheet steel securely bolted and braced together. The bins are furnished with either level or pocket bottoms. Those with the level bottoms are intended for stock put up in packages or boxes, while the



Economy Steel Bin.

pocket bottom bins are intended for such articles as nuts, bolts, screws, pipe fittings, etc. They are made in single sections to be placed against the wall or in double sections placed back to back. Every bin is accessible. They are fireproof and can be supplied in any length or height. They are shipped knocked down, packed in crates.

"GARDNER'S IMPROVED" DISK GRINDER.

The accompanying half-tone shows a new disk grinder designed by Mr. F. N. Gardner, and built by the Gardner Machine Co., Beloit, Wis. The thrust of the spindle of this machine is taken at the right-hand box on hardened steel col-

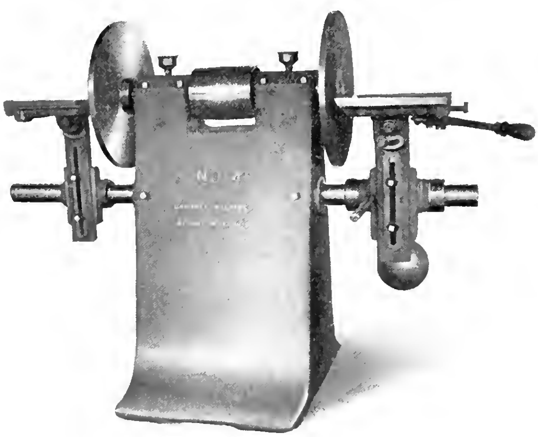


Fig. 1. Gardner Disk Grinder.

lars 4 inches in diameter, giving about 9 square inches of bearing surfaces at each end. These collars bear against cast iron surfaces plugged with babbitt. The design is such that if the spindle heats, the thrust bearing will loosen instead of sticking, as is the case with the usual arrangement. The construction of the work tables is sufficiently well shown in the half-tone. On the left hand table the top may be tilted to 45 degrees and the gage strip on the working surface is capable of swivelling an equal amount. The table at the right has a lever feed. By its use ample pressure of work against the feed can be obtained on all sizes and classes of work. The table is mounted on a gibbed slide which is protected from the dust by sheet metal guards on the under side. It is provided with T-slots for half-inch bolts. The movement of the table is limited by a fine threaded stop-screw at the back and an adjustable counterweight allows a correct balance to be maintained. This latter table is an extra attachment.

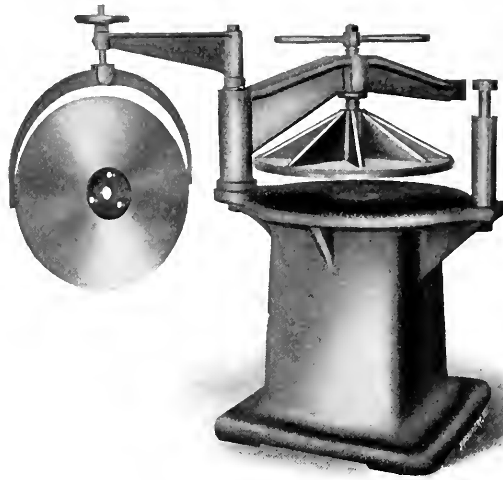


Fig. 2. Press for Cementing Cloth on Disks.

The wheels for this machine are 20 inches diameter by ¾ inch thick. The spindle is 2 inches in diameter with bearings 8 inches long. It is driven by a 7-inch pulley with an 8½-inch face.

Fig. 2 shows a process for cementing emery cloth to the disks. Pressure is obtained by a hand lever and screw. By means of the lifting attachment, heavy wheels can be handled with ease. The lifting arms can be used for only one size of wheel, but extra sets of arms with screw attached are furnished for any size desired up to 23 inches in diameter. By using this arrangement the wheels may be handled in a damp condition without the risk of displacing the cloth or the exertion of lifting, which are troublesome when the disks are shifted by hand.

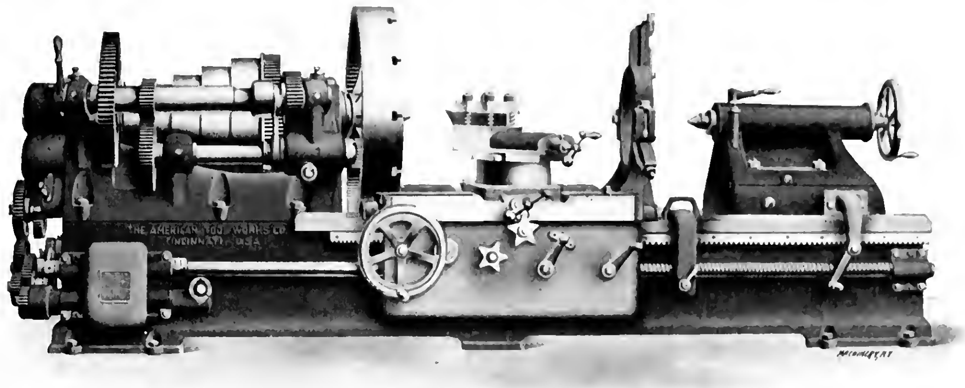
THE "STANDARD GUIDE" STEAM HAMMER.

The David Bell Engineering Works, Buffalo, N. Y., which makes an exclusive specialty of the building of steam hammers, has brought out a new line of single frame machines which is called the "Standard Guide." The main frame of the hammer is cast without cores, excepting, of course, in the column, which is of box section. This gives uniformity of thickness and shape to the casting. The bed plate is solid with the frame, with heavy ribs below the floor, and reinforced around the die block. This pattern of hammer takes its name from the fact that the main casting to which the lower ends of the slides are bolted is made stronger and heavier than usual. This overcomes a weak point in this type of hammer, and greatly strengthens the place where the most strain comes. They are regularly made in seven sizes, ranging from 350 to 2,000 pounds falling weight.

FORTY-TWO INCH "AMERICAN" LATHE.

As the half-tone shows, this lathe is of massive design throughout. It is one of a new line which the builders, the American Tool Works Co., Cincinnati, Ohio, have built to meet the requirements of modern practice. The feed is driven through a quick change gear mechanism which provides 32 changes for feeding and thread cutting, the range of threads being from one thread in 4 inches to 16 threads per inch, including 11½ pipe thread. The feed range is from 6.4 to 92 cuts per inch. The device is operated while the machine is

running, if necessary, by a revolving nut seen at the right of the gear box beneath the head, which moves a sliding key engaging two opposite gears, each being one of a cone of gears which is encased in the gear box. The feed or screw pitches thus obtained are multiplied by the compound gears on the quadrant at the end of the head, it being necessary to change one gear only on the quadrant for each additional thread. This arrangement gives flexibility to the screw cutting mechanism, making it possible to cut an unlimited number of sizes of threads or worms, either finer or coarser than the range indicated above. An index plate is provided to assist in obtaining the desired feed or pitch.

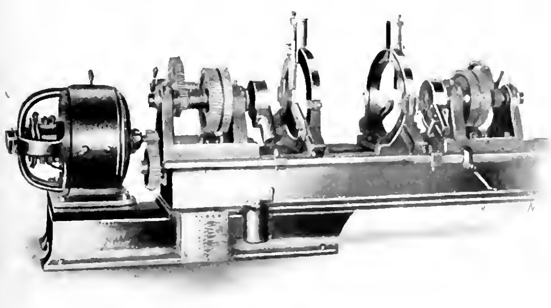


American Tool Works Co.'s Forty-two Inch Lathe.

The head stock is triple geared with bearings of phosphor bronze, and with the five-stop step cone divides the feed range into 15 steps in geometrical progression. The feed may be reversed in the apron, a feature which is valuable on a long lathe where the tool may be working at some distance from the head stock.

DOUBLE HEAD FACING MACHINE.

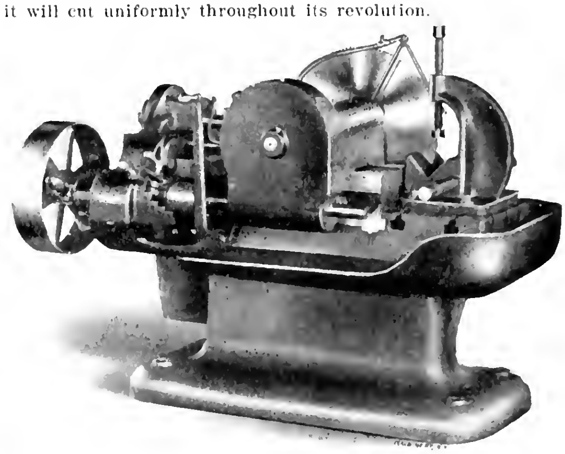
The accompanying half-tone shows a facing machine built by Fay & Scott, Dexter, Maine. It is designed to be used for facing the flanges of pipes, pipe fittings, and similar work, held in stationary fixtures on the bed. The head at the left-hand end is fixed, while that at the right is adjustable to suit the length of the work. Power is applied to the spindles on these two heads through a splined shaft, which is driven from the motor, as shown in the cut. On the nose of each spindle is mounted a star feed head, carrying a slide to which the cutter is fastened. Each head is furnished with back gears, and these, in connection with the variation obtainable in the motor, give the requisite range of speeds. The motor has a variable speed of from 470 to 1,400 revolutions per minute, and is rated at 10 horse power. This particular machine was mounted on a 26-foot bed, and its total weight was 15,000 pounds.



Fay & Scott Double Head Facing Machine.

NO. 5 COCHRANE-BLY METAL SAWING MACHINE.

This cold saw was designed with the idea in mind of giving it as great convenience, productive capacity, and neatness of design as the experience of its builders was capable of. Among the new features is the arrangement of the ways on which the carriage slides. At the saw side, where the strain is upward, the carriage is guided by a shelf solid with the main casting which bears on the underside of the way, the adjustment of wear being taken care of by a taper gib which is interposed at this point. On the opposite side another taper gib is used to take care of lost side motion. To still further increase the rigidity of the machine, the usual construction involving the use of a split box for the saw spindle has been discarded and the bearing is made solid. The saw arbor is of large size, case hardened and ground to true cylindrical form. The saw is mounted on an expansion bushing at the end of the spindle, which thus centers it, and gives assurance that it will cut uniformly throughout its revolution.



Cochrane-Bly Cold Saw.

The feed screw is made as large as practicable and placed directly in back of the saw. This screw and its nut are of the same length and the nut is split to allow all slack to be taken up. The screw is driven through a worm and wheel by a cone of gears, giving five changes of speed. An automatic stop shuts off the feed and returns the carriage for another cut. The spindle is driven by a pair of steel spur gears through a large cast-iron worm wheel and a case-hardened triple worm of coarse pitch. The driving shaft is back geared, giving a choice of two speeds to the spindle. The drip pan under the saw returns all oil to the tank at the back of the machine, whence a positive-geared pump provides an abundant supply at the cutting point. The work table is provided with T-slots for holding fixtures for special work, or the work may be strapped directly to the table and the full section of the saw outside of the collar utilized. With the machine is furnished a vise for ordinary round or square stock and a stand to support the free end of the bar. This cold saw is built by the Cochrane-Bly Co., Rochester, N. Y.

A NEW METHOD OF FINISHING CRANKSHAFTS.

The series of photographs, of which reproductions are shown below, illustrate a machine and process, for machining crankshafts, which have recently been developed. The machine itself, as may be seen by reference to Fig. 1, is an adaptation of the vertical boring mill idea. The cross rail, which is adjustable as to height above the table, carries a single slide furnished with an offset tool post extending out to the center line of the table. The rough forging comes to the machine in the shape shown at the left hand of Fig. 2. It is placed

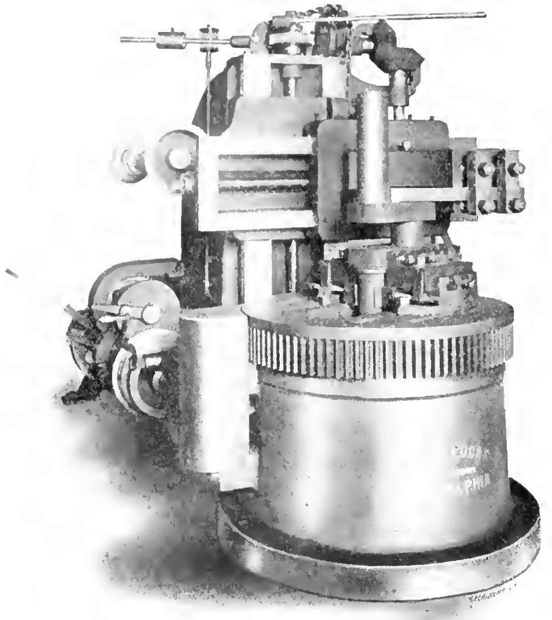


Fig. 1. Espen-Lucas Machine for Finishing Crankshafts.

in a specially constructed vise on the table of the machine, where it is grasped as shown in Fig. 3 by the lower cheek, with the lower journal extending down through the opening in the center of the table; an extended tool is clamped on the slide of the machine and used to work out the metal which in the forging fills up the throw of the crank. The advan-

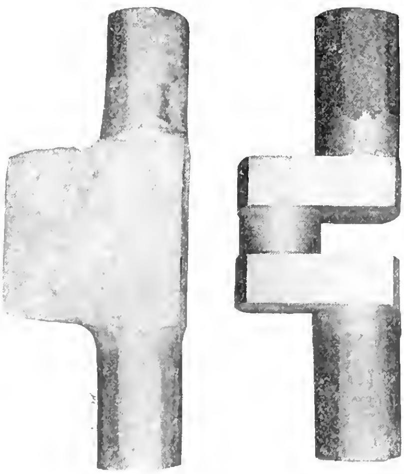


Fig. 2. The Forging and the Finished Product.

tages of performing this operation in this manner are plainly seen. The stock is held more firmly than would be possible in the lathe, since it is gripped close to the point where the cutting tool is at work. The rise and fall of the unbalanced weight of the forging which prevents rapid work when the piece is turned on centers is avoided, and, since the machine was made for this particular work, the unnecessary joints and sliding surfaces which bring down the efficiency of the lathe when performing this operation are avoided. The outside of the cheeks is roughed out in a similar manner as shown in

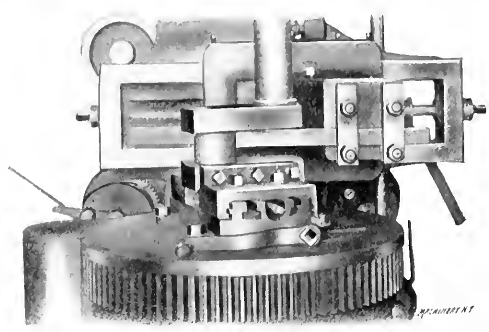


Fig. 3. Turning the Crank Pin.

Fig. 4, the vise being adjusted to bring to the center of the table, the center line of the shaft instead of the center line of the crank pin as before. A third adjustment of the vise brings the work into position to finish the ends of the cheeks.

After these cuts have been taken, the crank may be taken out of the universal vise, removed from the machine, and laid on the table to have the faces of the cheeks surfaced up, as may be dimly seen by the tool marks on the finished crank at the right of Fig. 2. The total time taken to rough out this crank from the forging was 1 hour and 30 minutes. This included cutting out the metal in the throw of the crank, turning off the ends and sides and turning up and finishing the outside of the cheeks, and finally facing off the top and bot-

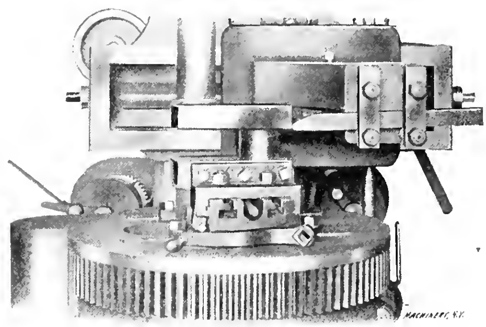


Fig. 4. Turning the Ends of the Cheeks.

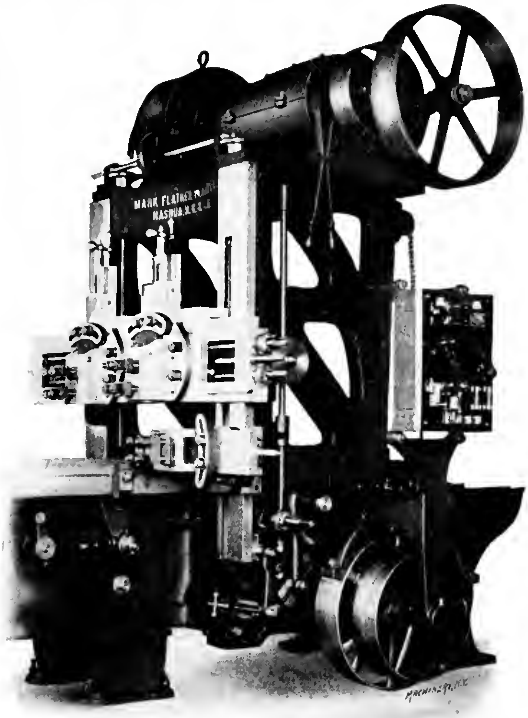
tom of the crank. This machine, with its attachments, can rough out and finish crank shafts having throws of 20 inches or smaller. The machine has automatic feeds in all directions. The gears are made of hammered crucible steel and the bearings are lined with bronze. The vise is furnished with graduations which facilitate the setting of work to varying lengths of throw.

This machine, which weighs 20,000 pounds, is built by the Espen-Lucas Machine Works, Philadelphia, Pa.

VARIABLE SPEED COUNTERSHAFT FOR PLANER.

The accompanying half-tone shows a Flather planer, built by the Mark Flather Planer Co., Nashua, N. H., fitted with a four-speed driving mechanism of recent design. The motor is directly connected with the shaft which extends through the gear box, carrying on the outer end the pulley which drives the reverse belt. This shaft, in the interior of the case, has keyed to it a cone of four gears which mesh with corresponding mating gears loosely mounted on a parallel shaft. This second shaft gives the cutting movement to the platen, through a belt and pulley mounted on its outer end. Any one of the four loosely revolving gears may be connected with the shaft on which they are mounted by throwing in a friction clutch,

of which there are four, one for each gear. These clutches are operated by the two levers which may be seen hanging down from the gear case at the side of the housing. Each lever controls two clutches, but an interlocking mechanism prevents the two from being thrown in at the same time. This arrangement thus gives a choice of four cutting speeds in combination



A Four-speed Planer Drive.

with a constant return speed. Its makers furnish it either as an attachment to the planer, or in detached shape as a counter shaft to be used with their own machine, or one of any other make.

SIXTEEN-INCH ROCKFORD SHAPER.

The Rockford Machine Tool Co., Rockford, Ill., are building the shaper shown in the cut. The column is made with overhanging ways at each end to give an increased support to the ram. The base is a pan construction for catching oil, chips, dirt, etc. It has a forward extension accurately finished for a table support. This table support is instantly adjustable to the height of the table and gives it a rigid support for heavy cuts. The ram has a screw adjustment for length of stroke and its position can be changed without leaving the work and with the machine in motion or at rest. The vise, which is made with jaws 10 inches wide and $2\frac{1}{4}$ inches deep, has an improved screw arrangement which draws the jaws together instead of pushing them, the thrust being taken by a steel collar nut, which relieves the frame of all strain tending to spring it or impair its accuracy.

The machine is driven by a 3-inch belt on a four-step cone connected to the crank through gearing, so arranged that the drive may be either straight or back-geared, the ratio being 6 to 1 for straight gearing and 19 to 1 when the back gears are engaged, with a range of from 8 to 76 strokes per minute. The cross feed is automatic in either direction. The feed-connecting rod adjusts itself to any height of rail. The elevating screw, which is of telescopic form, is provided with ball bearings and may be actuated by the same ratchet mechanism which gives the cross feed, thus providing a power vertical feed to the table. The shafting is of high carbon steel, with bearings bushed with bronze and provided with a self-oiling arrangement, fed by covered oil holes conveniently placed.

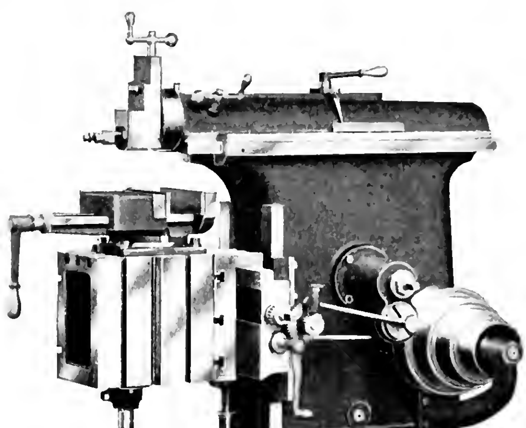
A FIVE THOUSAND POUND DROP HAMMER.

What is believed by its makers to be the largest friction board lift, drop hammer, in the world, has just been built by the Billings & Spencer Co., Hartford, Conn. It is to be used by the Bethlehem Steel Co. of South Bethlehem, Pa., in the manufacture of heavy gun forgings for government orders. The weight and dimensions of this drop hammer are in excess of those of any other tool of this class in the world.

The base weighs 72,526 pounds and the hammer itself 5,000 pounds. The uprights weigh 7,600 pounds each. The friction rolls weigh 1,200 pounds each and the roll spindles, rolls gears and oil guards are one piece forgings. The hammer, rough planed, weighed 5,600 pounds. These forgings were made by the Bethlehem Steel Company. The shoe forging weighs 2,240 pounds and the shoe key weighs 160 pounds. The dimensions of driving pulleys are 60 inches by 13 inches by $4\frac{1}{2}$ inches. The length of rear roll shaft is 94 inches; that of the front roll shaft 60 inches. The distances between the point of ways is 30 inches; the extreme fall of the hammer six feet four inches. The total weight of machine is 125,000 pounds.

* * *

Slowly but surely the wireless telegraph is finding its place, but its work is not yet the displacement of the wire telephone and telegraph lines. It rather is a valuable auxiliary to the wire lines, filling the gaps they cannot. For example: it is reported that the United States Government is preparing to install a wireless telegraph system throughout the lower Yukon Valley in Alaska, using it to replace the land lines that have proved failures on account of the difficulty of maintaining them in the face of forest fires, floods, cold weather and other obstacles. But as this region becomes more thickly settled, if it ever does, the wire lines will undoubtedly be restored for the reason that it is not probable that the wireless systems will ever be capable of the ramifications of wire



Sixteen-inch Rockford Shaper

lines. Wireless telegraphy will find its use on the sea, the desert, and in the uninhabitable areas generally, where the maintenance of wire lines is difficult and costly. It is not to be inferred from this, however, that wireless telegraphy is cheap for, on the contrary, it is costly under the present conditions of installation and operation. The report that Professor Braun has discovered means for projecting the waves in one direction only has aroused much interest, as such a system would undoubtedly greatly extend the possible uses of wireless telegraphy, for it would reduce the cost of operation and lessen the interference in territory where a number of instruments are working simultaneously. In short, it would put wireless telegraphy more nearly on a par with the wire system in the matter of effectiveness and secrecy.

THE ECONOMY OF THE GAS PRODUCER POWER PLANT.

The two articles reproduced below are suggestive along the line of determining the conditions which limit the future fields of the various prime movers. The first discussion is taken from the October number of *Power;* the second was contributed by J. H. Kinealy to the *Engineering News*, issue of September 7.

IS GAS POWER MORE ECONOMICAL THAN WATER POWER?

That power can be turned out of a gas-power plant for less cost than from a water-power plant seems at first thought to be almost incredible, and in order to show how this may be, the writer begs to present the following analysis of costs. That we may be fair, we will take our data of the water power from a prospectus before us, detailing the cost and probable results in the development of a water power of 20,000 H. P.

From other data we find the estimate given in it compares favorably with several of the larger water powers that have been built, so it is fair to take this one as an example, and quoting from the figures therein, we have the total cost of the water-power plant at $3,555,000. This includes land, dams and canals, power station and electrical equipment, transmission lines, etc., of a plant ready for continuous operation. This is $177 per horse power.

The following estimate of the cost of operation, etc., is also taken from the prospectus:

Operating expenses per annum	$ 46,000
Interest $3,555,000 at 5 per cent	177,750
Sinking fund	100,000
Repairs and depreciation	93,000
Taxes and insurance	25,000
Total	$441,750

This plant is located at a point requiring 100 miles of transmission line.

It is perfectly fair to assume the gas-driven plant as located within this distance of a very large center of population and yet put it directly at the mine. Hundreds of mines are as near Pittsburg, Cleveland, Columbus, Indianapolis, St. Louis, Omaha, Baltimore and numerous cities of from several hundred thousand to more than a million population. So we will place our gas plant at a mine, and will assume 65 cents per ton as the price of slack coal in the hoppers of the producer. This would probably be more profitable than shipping the slack, as the producer uses mostly slack, leaving the lump for shipment.

The cost of this plant of the same capacity as the water power ready for continuous operation would not exceed $2,325,000 or $116 per horse power; consisting of gas engines, by-product producers, electrical equipment, buildings, land, transmission lines, etc., as in the case of water power ready for continuous operation. The operating costs are very nearly as follows:

Labor	$ 50,000
Interest $2,325,000	116,250
Sinking fund	75,000
Repairs and depreciation	116,250
Insurance and taxes	15,000
Total	$372,500

The plant we are proposing is located at a bituminous mine and we would only consider a by-product installation, as herein lies a great source of profit.

Every ton of bituminous coal contains from 70 to 85 pounds of sulphate of ammonia. This is worth 3 cents per pound and holds steadily at about this price. From plants in operation it is found that the average net result from the by-products is fully $1.10 per ton of coal gasified, after deducting the cost of sulphuric acid, etc., used in the process.

It is expected that the water-power plant to which we refer shall deliver power to so varied a custom that it will be practically uniform, as the peak loads of lighting and railway plants shall be taken care of by local plants and storage batteries, so that a load factor of 85 per cent may be assumed, at least for the sake of comparison.

A plant of 20,000 H. P. capacity will deliver say an average of 17,000 H. P. every day in the year, with a coal consumption of 96,798 tons. As each ton of coal nets $1.10 in by-products, this tonnage would yield $106,477. The coal bill for 96,798 tons at 65 cents is $62,918.

The net result then from the by-products is, the coal paid for and $43,559 placed to the credit of the expense account, and beside this gas sufficient to run 17,000 H. P. every day in the year.

The operating account will now stand	$372,500
Less profit on by-product	43,559
	$328,941

In order to make the comparison as nearly correct as possible, we will assume that each plant delivers 17,000 H. P. or 111,100,000 kilowatt-hours per annum and that this may be sold at 1 cent per kilowatt-hour, aggregating $1,111,000, with the following result:

	Total Receipts.	Operating Expenses.	Net Receipts.	Percentage of Profits on Investment.
Water power	$1,111,000	$441,000	$670,000	18.85
Gas power	1,111,000	328,940	782,060	33.64

From these figures it would appear that, given a coal mine and a water power equidistant from, say, Chicago, the coal mine can sell slack coal to the gas plant at 65 cents (in which there is a profit), ship the lump at an increased price, transmit current and beat the water power 14.8 per cent in results, not to consider the sale of coal direct. It will be remembered that these figures are only for the sake of comparison, as the cost of coal and the price of current will vary in every case, and the latter is put at an extremely low figure.

COMPARING THE PERFORMANCE OF GAS-PRODUCER AND BOILER PLANTS.

In the preliminary report on the operations of the coal testing plant of the Geological Survey, at St. Louis, Mo., it is stated that comparative tests of 14 bituminous coals from nine States, show the power efficiency of these coals when used in the gas-producer to be two and one-half times greater than their efficiency when used in the steam boiler plant; or, in other words, 1 ton of these coals used in the gas-producer plant has developed, on a commercial scale, as much power as 2½ tons of the same coal when used in the ordinary steam-boiler plant.

This statement means that the preliminary tests have shown that for power purposes a gas-producer plant will use only 40 per cent. of the fuel that would be used by the ordinary steam plant to develop the same power. It is well to bear in mind, while considering this statement, that what those in charge of the tests called an "ordinary steam boiler plant," was a steam plant in which the engine was a non-condensing engine of the Corliss type whose water rate was 26.3 lbs. of steam per hour per horse-power developed.

The boiler plant and the gas-producer plant were each of between 200 and 250 H. P. capacity, and we are told on page 118 of the report that the "labor required would be the same for the operation of either the boiler plant or the gas-producer plant of the capacity under tests. In either plant two men would be sufficient." This means that the difference in the costs of operation of the two plants is equal to the difference in the cost of fuel alone.

In estimating the relative economy of gas producer and boiler plants, however, account should be taken of the requirements for heating the establishment where the power is used. In general, fuel for any establishment, whether a factory or not, is used for power purposes and for heating; and the relative cost of the fuel used for each depends upon the purpose of the establishment and upon its location. For most places in the United States north of the Ohio River it is usually necessary to provide heat for heating purposes for a season of about six months. Therefore, when considering the relative cost of fuel for a steam plant and a gas-producer plant for a given establishment, we may say that, for one half of the year fuel must be used for power only, and for the other half of the year fuel must be used for power and for heating.

When the power plant is a non-condensing steam plant, the weight of fuel required for power and heating depends very largely upon the relative amounts required for each. When the quantity of steam required for power is greater than that

required for heating, the weight of fuel required for heating will be practically nothing; because by the use of a properly designed and installed heating system exhaust steam from the engine may be used for heating purposes with very little or no back pressure being brought onto the engine, and hence with little or no increase in the fuel required for power during the heating season. If the steam required for heating is greater than that required for power during the winter, then the fuel for power during the winter need not be considered, because all of the exhaust steam from the engine supplemented by live steam from the boilers, will be used for heating, and the engine will simply serve as a reducing pressure valve for such steam as passes through it before entering the heating system. Hence the fuel required during the heating season will be that required for heating only.

We see, therefore, that for the ordinary non-condensing steam plant we have two cases to consider.

(1) When the steam required for power is greater than that required for heating. Here the fuel required during the heating season is what would be required for power only.

(2) When the steam required for heating is greater than that required for power. Here the fuel required during the heating season is what would be required for heating only.

When a gas producer-plant is used for power, the weight of fuel used during the winter is the sum of that required for power and that required for heating, because there seems to be no way as yet of using the exhaust from the gas engine for heating purposes. Hence when a gas-producer plant is used for power a separate steam plant must be installed for heating purposes. This means, of course, that if the steam plant required for heating purposes is large, more men may be required than would be required for the power plant alone; and the charges for labor for the operation of a combination plant consisting of a gas-producer plant for power and a steam plant for heating may be greater than the labor charges of a steam plant for both power and heating.

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DATA ON THE USE AND PERFORMANCE OF STEAM TURBINES.*

The type of apparatus to be used, whether alternating or direct current, will not materially affect the design of the station except in so far as the question of the use of reciprocating engines or steam turbines is involved. Up to this time the steam turbine, which is rapidly growing in favor for electric railway work, has been designed almost exclusively for use in connection with alternating-current generators, and the manufacturers of electrical apparatus have held out scant encouragement that its speed could ever be so modified as to make its use with direct-current generators, particularly the larger sizes, practicable. Reciprocating engines have, therefore, been regarded as the only type of steam motor available for this class of work. It is probable that this will be the case for some time to come, but it is interesting to note that considerable progress is being made in the development of direct-current turbo-generators. A number of machines of this type as large as 500 K. W. capacity are in operation, and work is well advanced upon units as large as 2,000 K. W. There seems to be good ground for the belief that this problem will be successfully solved, and that in the near future this type of apparatus will be available in sizes as large as are generally required for direct-current work.

Engineers and steam users generally have been prepared for some time to welcome any form of prime mover which could be shown to possess any considerable advantage over the reciprocating engine, as the latter had come to be regarded as having largely fulfilled its possibilities, and no very great improvement in economy was to be looked for. The steam turbine seemed to offer the solution of the question, and while, at the time of its introduction into this country, its superior economy had not been demonstrated, its great simplicity as compared with reciprocating engines, lower first cost, and less floor space occupied, insured its prompt adoption by a large number of power users, and from the first its progress has been rapid. In a report of the committee for the investigation of the steam turbine made to the National Electric Light Association last June, it was stated that there were in operation at that time 221 turbines of an aggregate capacity of over 350,000 horse power, the greater number of which had been installed in the last two years. The writer is informed that the orders for turbines taken by the largest two manufacturers in this country aggregate (July 1, 1905) over 800,000 horse power.

It is to be regretted that most of the data upon the efficiency of steam turbines has been derived from tests covering very short periods of time, usually only a few hours, and that so little data is available of their performance under actual service conditions. To the street railway manager or engineer, power station records for long periods, showing the coal consumed per kilowatt-hour, or, better still, the efficiency of the plant expressed in percentage of heat energy in the coal converted into electrical energy at the switchboard, are of much greater interest and value than the record of any number of short-time tests for steam consumption only, as it provides him with a much more practical means of making comparisons with the performance of other stations with which he is familiar. The data which has been published illustrating the relative economy in steam consumption of turbines and reciprocating engines rarely ever shows comparisons between units operating under identical conditions as to steam pressure, superheat, or vacuum and therefore does not fairly represent the relative performance of the two types, and, too, the steam consumption of the auxiliaries is also invariably omitted, so that it is impossible to form an intelligent opinion as to the additional cost of the higher vacuum required for the turbine.

Up to this time most of the turbines installed in electric railway power stations are operated in connection with reciprocating engines, and owing to the difficulty of separating the operating charges, it has been practically impossible to obtain reliable information as to their performance under commercial conditions.

One of the plants where turbines are exclusively used is the Quincy power station of the Old Colony Street Railway Company and through the courtesy of P. F. Sullivan, president of this company, the writer is permitted to publish some information regarding the performance of this station. This information was kindly furnished by C. F. Bancroft, superintendent of motive power and machinery.

It should be stated at the outset that this station, which will eventually furnish power for that portion of the Old Colony Street Railway Company's system, extending from Quincy on the north to the city of Fall River on the south, is not yet in full operation. Its connection with the latter city, where a large part of the current is to be used, has not yet been made, so that at present it furnishes power for only about one-third of the number of cars which it will eventually drive.

The station contains five 2,000 K. W., 4-stage vertical turbines, running at 750 R.P.M. and connected to 13,200-volt, 25-cycle alternating-current generators. The steam pressure is 200 pounds. There are ten horizontal water tube boilers of 750 horse power each, equipped with internal superheaters, giving to the steam an average of 65 degrees superheat. Under-feed stokers are used. There are no economizers. One turbine is supplied with steam-driven auxiliaries; the other four have motor-driven auxiliaries. At present, while only two units are in operation, the feed water is heated to 200 deg. F. by the exhaust from the steam auxiliaries. The average daily output is 52,500 K. W. hours, giving a load factor of 51.7 per cent for the two machines. Georges Creek Cumberland coal is used, having an average calorific value of 14,000 B. T. U. per pound. The average coal consumption for this station, operating under the conditions outlined above, is 2.94 pounds per kilowatt-hour, showing an efficiency of 8.36 per cent. This record covers a period of six months, ending June 30, 1905.

While this performance does not furnish conclusive evidence of the superiority of the turbine over reciprocating engines in electric railway work, it compares favorably with the results obtained in a large number of the better class of stations using the latter type of prime movers, and gives some force

* From paper upon power plants, by Fred N. Bushnell, before the Philadelphia Convention of the American Street Railway Association.

to the opinion that in actual practice there will be found to be very little difference in the coal consumption of steam turbine and reciprocating engine plants operating under similar conditions.

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FRESH FROM THE PRESS.

ELEMENTARY COURSE IN MECHANICAL DRAWING. Parts 1 and 2. By W. D. Browning, Editor of the *Draftsman*, and F. H. Sibley, Instructor of Drawing and Machine Design, Case School of Applied Science. Published by Browning Press, Cleveland, Ohio. Price 50 cents each.

The first part gives the usual directions for the selection of instruments and material, and then follow chapters on lines, lettering and figuring, geometrical problems, or orthographic projections. The second part contains chapters on development of surfaces, helices and screw threads, working drawings, lettering and blueprints.

PRACTICAL PLANER KINKS. By Carroll Ashley. 80 pages 5 x 7½ inches; 32 illustrations. Published by Hill Publishing Co., N. Y. Price $1.00.

This book is good so far as it goes, but contains too little matter to ask a shop man to pay one dollar for it. Not but that he could easily glean many times more than it cost from a careful study of its contents, but in these days of low-cost technical publications the price seems out of proportion. The cuts in many cases could have been made larger profitably, and we are sure that the writer out of his abundant experience could have added more practical matter on planer practice—a subject, by the way, on which too little has been written.

A COURSE IN TINTING. By W. B. Browning. Published by the Browning Press, Cleveland, Ohio. Price in paper, 30 cents; in cloth, 50 cents.

The book gives practical directions for tinting drawings, and five color plates showing examples of tinting. In view of the fact that some of the technical schools have introduced a small amount of such work in drawing courses, the booklet will perhaps meet with some demand in such directions. There is doubtless, however, more demand for some instructions on making wash drawings of mechanical subjects, especially in perspective from the usual three-view drawings. If a manufacturer can present to possible customers a counterfeit resemblance of what a certain machine will look like when complete, it will often result in obtaining orders before any expense is incurred in the actual construction of the machine and this, of course, is quite desirable with machines of a special nature having a limited sale. It would appear that a course along these lines would meet with favorable reception among the drafting fraternity.

ESSENTIAL DATA ON BEVEL GEARING. By Edward J. Frost. 243 pages 4½ x 5¾ inches. Published by Edward J. Frost Publishing Co., Jackson, Mich. Price $5.00.

This book is intended as a reference book and time-saver for the drafting room and shop, particularly the latter. It represents an enormous amount of personal work on the part of the author, containing upward of 70,000 calculations, which have been arranged in convenient tabulated form and which form the main part of the book. Besides the main tables, there are several other tables and diagrams in the preliminary pages. These preliminary pages are given up to brief discussions of the elements of bevel gearing and shop methods under the following heads. Relative Sizes of Teeth with Large and Small Ends, Tooth Parts Definitions, Corrected Addendum and Chordal Thickness of Tooth, Methods of Cutting and Use of the Tables. As stated, the bulk of the book, 224 pages, is occupied by the gear tables for pinions and gears at right angles, beginning with 9-tooth pinion table, and concluding with a 70-tooth pinion table. Each table gives the face angle of the pinion, cutting angle, outside diameter for 1 pitch, backing for 1 pitch, number of cutter to use, back angle and pitch cone radius. The back angle and cone radius are the same for both pinion and gear. The face angle, the cutting angle, outside diameter, backing and number of cutter are also given for the mating gear in each case. The first table starts with a 9-tooth pinion and gives this data for it and mating gears up to 132 teeth by intervals of one tooth. The following table gives the same data for a 10-tooth pinion and mating gears up to 132 teeth, and so on up to a pinion of 70 teeth, each table giving the elements of both pinion and gear up to 132 teeth. It is obvious that a reliable book of this kind will be most valuable to the busy shop superintenent or foreman as it gives the necessary data for turning and cutting almost all bevel gear blanks likely to be met with in practice. Of course this data cannot be used directly, except in the case of the angles and gears of 1 pitch, but the simplicity of the calculations necessary to change the data to any required pitch makes them easily mental processes in most cases. Each table starts, of course, with the number of teeth by which it is designated so that each table is one place shorter than the preceding one, but the data for all pinions and gears within the limits of numbers named is included. It would be especially valuable on repair work, and should save its cost many times over where much of such work is being done. Being of a convenient pocket size, it can be carried on the person and referred to whenever required. Mr. Frost cannot claim absolute accuracy for the tables, but he has carefully checked all calculations and believes that they are, with very few exceptions, correct.

NEW TRADE LITERATURE.

E. G. SMITH, Columbus, Pa., catalogue giving list of all sizes and styles of Columbia calipers, and describing the special advantages of the individual types.

NORTHERN ELECTRICAL MFG. CO., Madison, Wis. A leaflet describing and illustrating Northern forge blowers. A table giving the general details and an idea of the capacity, etc., is appended.

THE CRANE CO., Chicago, Ill. Circular No. 295 E of Craneweld Flanged Pipe Joints describing the process of making and giving dimensions and prices. Illustrated.

THE B. F. STURTEVANT CO., Hyde Park, Mass., have sent to their friends a Boston time table with an invitation to visit them at their plant.

AMERICAN PULLEY CO., 29th and Bristol Sts., Philadelphia, Pa. A leaflet containing an extract from a report of tests of the American pulley made at Cornell University.

FOOS GAS ENGINE CO., Springfield, Ohio. A catalogue of Foos Gas and Gasoline Engines. A general description is followed by some remarks on the important features, and illustrations of the engines.

NORTHERN ELECTRICAL MFG. CO., Madison, Wis. Bulletin No. 51 describing the construction of Northern Ring Type machines. Details of special parts are given and the bulletin is well illustrated throughout.

ARMSTRONG MFG. CO., Bridgeport, Conn. New catalogue of Armstrong Stocks and Dies, stating the points of superiority of these over other stocks and dies and describing their various types. An index is given in the front.

THE NATIONAL MACHINE TOOL CO., Cincinnati, O., have published a booklet entitled "Busy Men's Opinions," containing letters of recommendation for their key-seating tools. These letters are written by firms who have used the tools and have found them to give entire satisfaction.

THE R. D. NUTTALL CO., Pittsburg, Pa. Catalogue describing briefly their plant and products. It contains many illustrations. The new gear cutting machine which they have lately installed allows the cutting of gears up to 20 feet in diameter, 3 feet face and 7 inches P tooth.

THREE RIVERS TOOL CO., Three Rivers, Mich. Circular of the Mathews Core Drills and Reamers, with high-speed steel inserted blades, which render the tools more efficient than when made of carbon steel, and much less expensive than if made entirely of high-speed steel.

THE BLAISDELL MACHINERY CO., Bradford, Pa. Bulletin 15, Type A Compressors gives tables with specifications of simple and duplex steam-driven and belt-driven air compressors. It is well illustrated with half-tones showing the machines as wholes and their special parts.

BAUSH MACHINE TOOL CO., Springfield, Mass., have issued an attractive catalogue on Drilling Machines. The interesting introduction describes the adjustable multiple spindle drills and invites attention to the illustrations of the machines which they have made. A list of firms using their machines is also given.

THE CLING-SURFACE CO., Buffalo, N. Y., have issued a leaflet containing letters from the Broadhead Worsted Mills and the Consolidated Lamp & Glass Co., which testify to the excellence of Cling-Surface as used on their belts. By means of this, slack-running belts may be used and the extra expense in time and money of overcoming friction is done away with.

THE GISHOLT MACHINE CO., Madison, Wis., have sent out an attractive and original catalogue in the form of a booklet called "Don'ts for Machinists." The list of Don'ts as published in MACHINERY occupies several pages, while the few remaining pages are devoted to Gisholt turret lathes, boring mills, horizontal mills and tool grinder. This is an interesting job of printing.

THE CROCKER-WHEELER CO., Ampere, N. J. Flyer No. 276, entitled Automatic Belt-Tightening Idler described a newly-designed automatic belt-tightening attachment for the standard Crocker-Wheeler Form L motor. It may be used wherever the limited center distances between pulleys require an increased belt contact on the pulley surfaces, as on the Lanston Monotype machine.

THE INGERSOLL-SERGEANT DRILL CO., 11 Broadway, New York City. Form 52 A on Coal Mining Machinery, giving a brief description of boring machines, coal cutters, etc., and referring to preceding publications which contain complete information on these topics. Also Bulletin No. 2004 on Stone Working Tools. Some interesting examples of architectural stone cutting are shown.

PHILADELPHIA GEAR WORKS, INC., Philadelphia, Pa. A comprehensive Gear catalogue containing lists of the varieties of gears. This catalogue also contains other interesting information in the form of rules for sizing gears, table of tooth parts, bevel gear chart, and description of the method of drawing the bevel gear, spur gear wheel, and standard involute tooth.

THE AMERICAN BLOWER CO., Detroit, Mich. Catalogue of Heating Apparatus. Interesting descriptions of the various types of heating and ventilating fans are given and their special uses are set forth. A system of ventilating a school room is described and illustrated. With this catalogue is a list of specifications of their Vertical High Speed Automatic Engine and a treatise on the relative cost and return of their fans and blowers.

MINER & PECK MFG. CO., New Haven, Conn. Catalogue of Peck Automatic Drop Litter. By means of this lifter the hammer is brought from a state of rest gradually instead of being jerked up suddenly, thus securing uniform blows. The New Model Lifter has the weight of the parts removed from the lifting shaft and a heavier blow is thus secured. Their drop presses, blast forges, and wind gates are also described and illustrated.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Catalogue No. 50, Electric Trucks, describing and illustrating their recent electric trucks made for various railway companies. Also Catalogue No. 53, containing notes on the balanced compound locomotive taken principally from a paper on this subject read before the Richmond Railroad Club, and from articles published by various technical journals. The different types are illustrated and described.

W. P. DAVIS MACHINE CO., Rochester, N. Y. Catalogue F of machine tools, engines, boilers, and supplies. This is a cloth-bound book of 400 pages, listing the large line of machinery and tools carried by this firm. This company manufactures all sizes of lathes from a foot-power lathe to a lathe of 42 inches swing, besides upright drills, key seaters and other tools. They also handle tools of a number of prominent firms, besides a large line of engines, boilers, factory and mill supplies, etc. The catalogue is for distribution among purchasers of machinery who are interested.

THE R. K. LEBLOND MACHINE TOOL CO., Cincinnati, O. Catalogue of milling machines. A general description of milling machines is given first which is followed by descriptions of special types. Also two catalogues on lathes. The same general plan is followed in these as in the milling machine catalogue—beginning with a general description of lathes, and going on to specifications of the individual types. One of the lathe catalogues is an expansion of the other, giving more types, and a little more detail of description. The catalogues are well illustrated throughout.

MANUFACTURERS' NOTES.

THE INGERSOLL-RAND CO., 11 Broadway, New York City, have established a branch office at Houghton, Mich., under the management of Mr. T. F. Lynch. A complete stock of repair and duplicate parts for all Ingersoll-Rand machinery will be carried at the new office.

THE WILMARTH & MORMAN CO., Grand Rapids, Mich., have been obliged to secure larger quarters, owing to the rapid increase of their business. They are now located near the corner of Canal and Leonard Sts., where they have secured a long-time lease with option of purchase.

THE S. OBERMAYER CO., Cincinnati, O., through their New York representative, have secured the contract for a complete brass foundry equipment for the brass foundry to be installed for the fire department of New York City. This will be a complete repair shop for the metropolis fire department.

THE AMERICAN BLOWER CO., Detroit, Mich., have large new contracts on hand. They are to provide the complete heating apparatus for the new Allegheny shops of the Pennsylvania lines west of Pittsburg, and the ventilating outfit for the Altman building, New York, and the Marshall building, Chicago.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis., offer to send their purchasers quotations on Northern machines for application to machines and machine tool drive upon learning of the class of work to be accomplished and the voltage of the power circuit from which the current is to be taken.

THE WAGNER ELECTRIC CO., St. Louis, Mo., manufacturers of alternating and direct-current motors, also electrical instruments, will break ground in November for their new factory, just outside the western limits of the city. The buildings will cover twelve to fifteen acres.

MACHINERY.

December, 1905.

FACTORY EDUCATION.

O M BECKER.

O. M. Becker.

The altruistic movement in the industrial world now gathering impetus is directing attention among other things to the responsibility of employers in respect to the education of their employees. It is a truism not altogether true that the American workingman is the most intelliment in the world. Undoubtedly there is much of truth in the boast, as there is in many another whereby we complacently put ourselves at the head of the procession. The American workingman may well be more intelligent than any other, as might be inferred from his acknowledged superiority as a producer. It does not by any means follow that he is as intelligent as he ought to be or may be. Indeed to one who has had opportunity (and what is more to the point, seriously embraced it) to make a study of the intellectual life and attainments of the employed as a mass, the showing is sadly disappointing. The piecework system, the minute subdivision of productive processes, and the jig—that is to say, the practical elimination of the skilled workman, using the words in their original meaning—these things to a considerable extent discount intelligence, and by the same token, discourage intellectual training. Given the jig, a simple machine, and possibly a little longer practice, the ignoramus can drill a hole as accurately as a college graduate can, and very likely in as short a time. Nevertheless it is universally conceded that in the long run the intelligent workman is the most efficient and therefore the most profitable to the employer.

The present tendency is toward the still further simplification of manufacturing processes, through the use of more complicated machines capable of doing what formerly required several. The manipulation of such a machine undoubtedly requires greater intelligence than that of the simpler one; so that we have the paradox of an increasing requirement for intelligent operatives with a relatively decreasing need for skilled workmen in the sense that a machinist is skilled. Furthermore this specialization of skill, so to speak, this tendency to replace the mechanic with the expert machine tender, obviously requires skillful and discriminating supervision, and at once raises the question as to how such supervision is to be secured. This is not, as might at first thought be supposed, a matter of minor importance, but one that has already come to be quite serious, in the west if not in the east. The reasons are not far to seek.

A visit to any large public school whose pupils come from the homes of wage earners will show that, with an entering class of say two hundred, the finishing or eighth year class will number not far from twenty-five, two-thirds or more of whom are girls. The classes hold up pretty well until about the fourth or fifth year, when a marked decrease in numbers takes place. The children are by this time ten to twelve years old, and are much out of school, even in states where compulsory laws require regular attendance until the age of fourteen or more. If employment laws are strictly enforced, the attendance is better; but even then many are kept out of school on one pretext or another. Usually the real purpose is to have the child do some sort of work which will be either directly or indirectly gainful. Having reached the legal age of exemption from school attendance, usually fourteen, the great majority of these children have not yet completed the eight years' course of the elementary school as they might have done, and except in few cases never do finish it. Most of the boys and a few of the girls at once drift into the factory, and a large percentage of the girls into the department store or office. Except for a very little time set apart in the elementary school course for manual training, these new fledged wage earners have had no training whatever, no preparation fitting them directly for the industrial competition into which they are now thrown and of which they at once become a part. Once in the whirlpool there is little hope that the deficiency in training will ever be made up. The dreadful monotony of factory life, relieved only by the artificial and highly-spiced recreation afforded by the dance hall and similar amusements, soon accomplishes its work, drowning the spirit, if ever there was any, in the hum-drum and noise of piece work—choking the intellectual life as certainly and completely as Niagara's whirlpool might the physical. The evening school and the correspondence school afford some opportunity. It is, however, an opportunity taken advantage of by a few only, the energetic and particularly ambitious who would raise themselves above their surroundings by other means, were these not available. From such as these, and the relatively few who continue their school preparation in preference to entering prematurely the industrial competition and later equip themselves with more or less technical training, the material for expert superintendence of the remaining submerged mass of workers must be drawn. But the available supply no longer equals the demand. Most managers have experienced the difficulty of getting the right man for the place, especially if the place were one requiring considerable knowledge of the business as a whole. An industry is lacking in some respect if it cannot to a considerable extent train up the men who are later to be the directing forces in it. Most businesses are not now doing it. Nor, on the basis of present systems is it possible to be done. The deadening effect of the meaningless repetitive processes which modern production, based on the minutest possible subdivision of labor, seems to make necessary not only destroys individual ambition in the factory hand, but enervates him to such an extent that he instinctively declines responsibility. Take a man from a machine and make him a straw boss or assistant to the foreman, and the chances are even that he will ask to be restored to the machine where he will not be under the necessity of thinking or of shouldering responsibility to which he has never been accustomed. Doomed from the moment he entered the factory door as a boy, he has never acquired sufficient strength to lift his head above his surroundings, and by choice remains among the submerged.

The same condition is manifest in the social and political life, the citizenship of industrial centers, and calls for serious consideration at the hands of publicists and those in control of the great industries. The stability of the existing order of things depends upon strength of character as well as intelligence among the citizenship, and this quite aside from economic considerations as affecting industrial organization. The inability of present school systems and courses to meet adequately the situation in the face of the present day factory

O. M. Becker was born near La Moille, Ill., 1869. He graduated from the Kansas State Normal School, after which he took up some university courses. He has made a specialty of industrial education and has taught in various schools. Latterly he was employed by the International Harvester Company as promoter of welfare and educational activities in the McCormick works and as superintendent of the McCormick Technical School. Also, while with this company he carried on extensive investigations with high-speed steels. At present he has a consulting practice for welfare and industrial education. He has contributed to the technical press as well as to popular periodicals.

methods strongly emphasizes the responsibility of employers to do something looking toward a reinforcement of the public school system and a mitigation of the evils resultant from the extreme subdivision of labor.

There are evidently two methods of attack, in the solution of this problem: increasing facilities for industrial and technical education, that is, for the adequate training of workers for their work; and a modification of the piecework system of labor. The latter may be neglected in this discussion for the reason that as yet there appears to be at hand no practicable substitute that is economically as satisfactory. There remains then the other alternative, that of education.

Factory education, or perhaps better stated, the education of factory operatives, is not an untried theory of the idealist. Level headed men have long seen the economic necessity for something of the sort, and as long ago as the time of Robert Owen factory schools were more or less effective agencies in the development of certain industries. The old apprenticeship system, inefficient as it was from the modern point of view, was one manifestation of the idea, and a powerful factor in the promotion of industrial progress. Its wastefulness of time and the development of the specialized machine tool have led to its practical disappearance, unfortunately leaving no organized means for the accomplishment of its purposes in its stead. A few far-sighted employers of large interests, to their great advantage as they stoutly maintain, have retained the apprenticeship system in a modified form, and make it part of an educational system conducted along with and as a part of their manufacturing plants. The Baldwin Locomotive Works, the Browne & Sharpe Mfg Co., the General Electric Co., and R. Hoe & Co. may be mentioned as notable examples in this country. The school conducted at the Hoe printing press works for more than thirty years, has developed to such an extent that it is recognized as one of the leading private trade schools in the country. Its graduates last June numbered thirty-four, a circumstance which alone would be sufficient to direct attention toward it. In this school, conducted quite outside conventional trade school lines, are trained the young men who make up the working force of a large factory, and among whom there is no lack of material for intelligent and thoroughly qualified superintendence when there is need for it. From it go out, usually after some years additional service with the company, men who take responsible positions in manufacturing plants in all parts of the country. The manager is not well informed who passes by an opportunity to take a Hoe man into his works.

The same things are true to a greater or less extent of the other and lesser developed apprenticeship systems or trade schools conducted by industrial concerns. They not only supply their own needs in the way of skilled men competent to assume responsibility, but in some degree help supply the needs of other employers. Carried on as an integral part of the business, most of the technical and mechanical instruction given by men actually engaged in the production of a commercial output intended to be in competition with similar products, the students or apprentices themselves, working under the identical conditions which they will meet everywhere in commercial shops, such a school becomes not only highly practical and efficient, but a source of profit rather than expense. It is surprising that so few employers have thus far recognized the economical significance of such factory schools, to the extent of establishing them in their own businesses. The present widespread interest in the subject indicates that the time is not far distant when it will receive the careful consideration to which its importance entitles it, and factory education will have become an established fact in all large industries.

But the technical training of employees is only one aspect of factory education. If intelligently carried on, it will necessarily include mental discipline and result in the acquisition of much collateral information. It will not, however, seek to develop particularly on the cultural side. Now it is precisely this, the want of a modicum of culture, the lack of something for the mind to feed upon, that makes the daily life of the factory pieceworker so empty, so monotonous, and so stultifying. His work necessitates practically no thought, and unless he comes to it with some intellectual equipment, or unless there is at hand some means for encouraging the acquisition of it, there is little probability that he will ever rise above himself and develop an intelligence which will make his life more tolerable and his services more valuable. The night schools, as found in the large cities, useful as they are, cannot cope with the situation, for reasons quite external to the schools themselves.

The working hours in manufacturing plants, rarely less than nine, and more often ten a day, together with the strenuous pace required, exhaust the workman to such an extent that very naturally the comfort of home, his "workingman's club," or some place of amusement or relaxation attracts him more strongly than the prospect of some future good through the expenditure of several hours additional effort in a night school. Of course some there are who have the ambition to make the effort. But these are exceptions; and it is with the mass, the average, of working people that we have to deal.

The problem is then to reach, if possible, the great majority of factory people, and to fix the responsibility for reaching them. Now there is no social principle more generally recognized than this, that collective society, through the organized state, is responsible for providing means and agencies through which every individual may be prepared in an elementary way at any rate, for right living—whatever that may mean. The privilege of requiring, within limits not very well defined, all individuals to make use of the opportunities provided, is also universally recognized. On the other hand, there is the undoubted right of the individual to enter upon the business of making a living at as early a time as practicable and consistent with the general welfare of the community. Also to be taken into account is the disposition of workingmen's children generally, whether from need or choice does not here signify, to enter upon an industrial career at the earliest age the state will permit, and therefore with the least preparation permissible. To draw a line of demarkation between the right of the community to the highest possible industrial and civic efficiency, and the right of the individual to determine for himself when he shall enter upon h's life work and the amount of preparation requisite for it, is no easy matter. It has been variously drawn, and the tendency is to draw it still further up; that is to say, to lengthen the time required for educational preparation. The cheap market price of child labor naturally inclines the employer to use as much of it as his business will warrant, the supply will permit and the state will allow. From such labor the employer reaps a profit entirely out of proportion with the loss sustained by society; and for his trifling earnings during those years that ought to be devoted to preparation, the individual himself pays the frightful price of condemnation to lifelong intellectual stagnation, slavery to the machine, and relative industrial inefficiency. For these things the employer, it would seem, is in some degree at least responsible, and is under moral obligation to make some return. True, moral obligations are not greatly regarded in business, especially in matters affecting immediate profits. But the folly of permitting so much latent power to go to waste, so much possible productive or executive skill to remain undeveloped, would suggest that it is only prudent foresight to provide some educational means whereby a larger life and greater efficiency may be developed in these individuals.

The extension to employees of educational facilities for development on broad or general lines, in addition to those of a technical character, from this point of view is of prime civic and economic importance and cannot be shirked by the employer who looks to his future interests and those of the community.

How such responsibility is to be met is a problem yet to be solved. Some attempts have been made, many, in fact, since Owen at New Lanark marked the year one of factory education more than a century ago by establishing the first infant school in the United Kingdom for the children of his work people. Few generalizations are to be deduced from the comparatively limited experiences. One thing, however, stands forth clearly; namely, that the efforts, of whatever character they may be, must be mainly directed toward the young, so that the problem becomes practically a boy and girl problem, just as all other education is primarily a boy and girl prob-

VARIABLE SPEED MECHANISMS.—6.

GEARED DEVICES.

When the design of a variable-speed mechanism necessarily includes positive drive, *i.e.*, toothed gearing, the possibility of making changes of speed by small increments is ordinarily thought to be impracticable, and is rarely attempted, although one device, illustrated in this article, outlines a more or less chimerical scheme for making an infinite number of speed changes within certain chosen limits. In friction devices the making of changes by small gradations is simple. The friction surfaces may be conceived as being composed of an infinite number of teeth of very short height, so that no matter what "pitch circles" are brought into contact, there is not the clash that must follow the indiscriminate mating of ordinary gears, of which the teeth are of measurable thickness, and

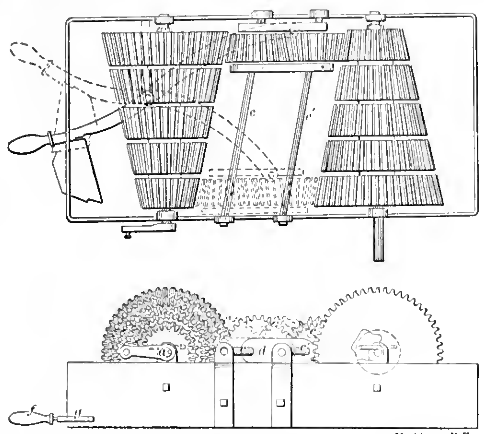

Fig. 58. The Idea of an Idealist. Patent No. 53,202, J. H. Wait, March 13, 1866.

the pitch circle must always be evenly divided. Hence, in gear devices nearly all designs make the changes by steps, which means that a multiplicity of gears of different pitch diameters are required to be so located that pairs representing the desired ratios may be brought into mesh to effect the desired change. The principle difference, therefore, between the various devices here described is in the manner that the change from one step to another is effected. If it were possible to make the changes with the facility that is outlined in patent No. 53,202 granted to J. H. Wait, March 13, 1866, and shown in Fig. 58, the problem of positive speed variation would have been greatly simplified, but the cheerful assurance of this inventor is hardly borne out by the cold mechanical

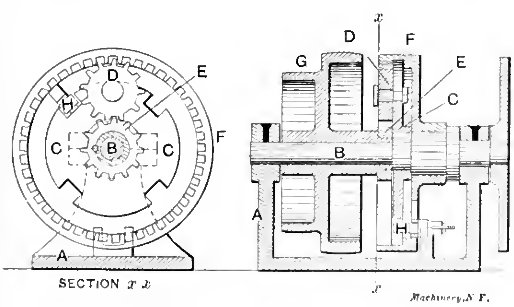

Fig. 59. A Two-speed Device by Alfred Betts, Patent No. 144,499, November 11, 1873.

facts and it is hardly necessary to say that his device for changing speed will not work. One cannot help being struck with wonder why such an impractical device was passed by the patent office examiners, and granted a patent. We hope that such a total lack of mechanical sense is not a characteristic of any of our patent office examiners at the present time.

November 11, 1873, Alfred Betts was granted patent No. 144,499 on a device for changing the speed of machinery. This invention was designed more especially for the needs of machine tools. In Fig. 59 *A* represents the headstock of a lathe, boring mill, drill or other machine tool in the bearings of which is "journalled" a spindle, *B*. To this spindle is keyed a notched disk, *C*, and upon a stud projecting from the notched disk is mounted an idler pinion, *D*. *G* is the usual cone pulley mounted loosely upon spindle *B* and having keyed to one end of its hub the pinion *E*, which meshes into the idler pinion, *D*. *H* is a stop which protrudes through and is adjustable in a slot cut through the side of the internal gear wheel,

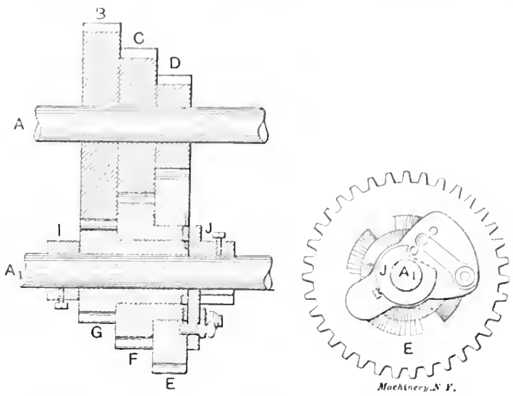

Fig. 60. Patent No. 204,585, granted to S. D. Locke, June 4, 1878.

F. By moving the stop, *H*, into one of the notches of disk *C*, the disk, spindle, and internal gear wheel, *F*, are locked securely together, thus making the cone pulley and spindle turn as one. When the stop is removed from the notched disk and engaged in a notch in the lower part of the headstock, motion is communicated to the spindle, *B*, and pulley, *G*, by the intermediate pinion, *D*, thus "multiplying the power at the expense of speed." In short, this device is a substitute for the familiar back gear generally used for lathes and other machine tools.

Fig. 60 shows a change speed gear patented by S. D. Locke,

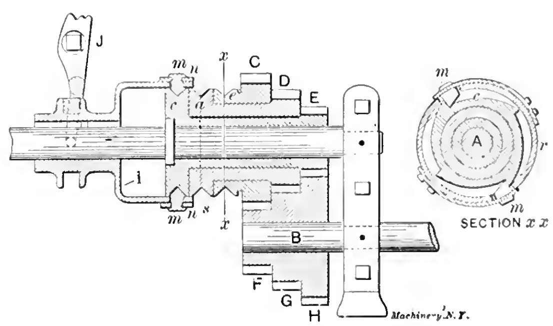

Fig. 61. Device of S. D. Locke, Patent No. 213,338, March 18, 1879.

June 4, 1878, No. 204,585, for grain binders. Two opposing cones of gears, *B*, *C*, *D*, and *E*, *F*, *G*, are mounted on parallel shafts, A A_1. Gears *G* and *F* are made with extended hubs so that portions of the right-hand faces of all three gears are in the same plane at the right. A collar, *J*, is secured to shaft A_1, which carries a swinging pin which can be engaged in notches in any one of the three gears, *G*, *F* and *E*. In this manner, three positive changes of speed are provided. The patent, however, is not limited to this particular construction, alternative devices being illustrated in the specifications, one of which provides that changes may be effected by the insertion of pins through both cones of gears in such a way as to lock them and make any opposed pair the driver and driven gears.

Another patent for a geared variable speed device also for agricultural machines was granted to S. D. Locke, March 18, 1879, No. 213,338, and is shown in Fig. 61. This patent provides an interesting method of effecting changes of speed, the changes being made without the necessity of stopping the machine. Gears *C*, *D* and *E* are provided with extended hubs which are circumferentially grooved. The grooves, however, are not continuous, but form in effect ratchet teeth as is shown in the cross section. The sliding sleeve, *I*, is enlarged into a

cup shape at the right end, and is feathered to shaft A so that it must turn with it, although free to be moved longitudinally by hand lever, J. Two inwardly projecting pins or pawls, m m, are provided at the right which engage the teeth in grooves c, a and e. When the hand lever, J, is moved so as to shift the sliding sleeve, I, the V-shaped pawls, m m, ride up over the sides of the grooves and fall into the next one,

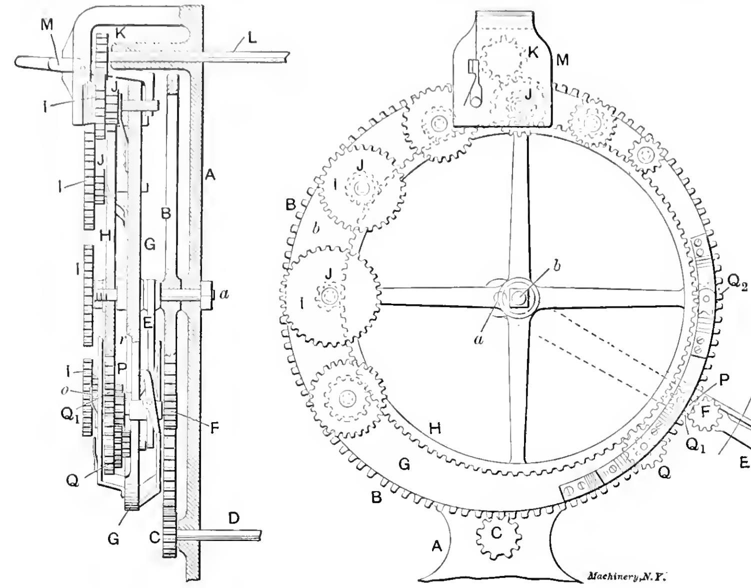

Fig. 62. Feed Changing Mechanism, Patent No. 276,463, granted to B. B. Powell, April 24, 1883.

thus converting that gear into a driver. While the changes of speed are neatly effected, this device has the bad feature that all the gears are running, and one gear being mounted upon another, the friction loss would be a maximum when C is the driver, as there would then be the condition of all three gears working under the load and running at different speeds.

The speed-changing mechanism shown in Fig. 62, No. 276,-463, was patented by B. B. Powell, April 24, 1883. While primarily designed as a feed-changing mechanism, it will be of interest in this connection, for of course the principles which are valuable in one are equally valuable in the other. In feed-changing mechanisms, however, as is the case with this, it is desirable to provide a large number of changes with comparatively low steps in velocity ratio. The head of the lathe or similar support is indicated by A, on which is mounted a center pin, a. Upon this pin is loosely fitted a spur wheel, B, which engages with and communicates motion to pinion C on shaft D. Next to and outside of this spur wheel, B, is the hand lever, E, which is mounted upon the center pin, a. This hand lever carries a pinion, F, which meshes with B. Outside of the lever, E, and loose upon the center pin, a, is the plain disk, G, and outside of disk G and mounted on an eccentric pin, b, is a spur wheel, H. Mounted on G are a series of gears and pinions, J and I, through which motion may be conveyed to H by means of pinion K. Provision is made for throwing the idle wheels out of engagement with H when not acting as intermediates between K and H. Motion is transmitted from gear H to gear G and thence to pinion C by means of one of the compound intermediate pinions, Q, Q_1, Q_2, and pinion F mounted on the hand lever, E. This lever may be shifted into three positions. To put it in mesh with gears Q, Q_1, Q_2, each of which, with the exception of Q_2, effect a change in velocity ratio, in addition to that effected at M. With this arrangement it is apparent that twenty-one changes of speed may be effected by changing the position of the disk, G, so as to bring various intermediates in mesh with K, and by shifting the hand lever, E, so as to change the velocity ratio between H and G.

A changeable speed gearing was patented October 21, 1884, No. 307,002, by H. Bickford and A. Armitage, which is illustrated in Fig. 63. This is another example of a positive change speed gearing for agricultural implements, this device being for grain drills. Motion is transmitted to the gearing by shaft A, on which is mounted a pinion, B, meshing with five pinions, F, F_1, F_2, etc. These latter are mounted in a circular frame, E, having notches on its periphery by which any gear may be held in a fixed position relative to J. Each of these gears, F, F_1, etc., have squared shafts on which an intermediate gear, G, can be slipped, so as to communicate motion to J. To double or triple the possible speed changes gear G is made with two or three steps, and J, with its train of gearing, is shifted sideways so as to be in the same plane with the pinion with which it is to be brought in mesh. The mechanism for doing this and for shifting J toward the shaft A is not clearly shown.

An ingenious method of changing from one speed to another in a geared variable-speed mechanism was patented by R. N. Dyer, September 27, 1898, No. 611,378. The principal of this device is illustrated in Fig. 64, the idea being the use of eccentric gears between the working gears which are used as the means of translation from a low to a high step, or *vice versa*. In the illustration C, D and E represent the three working gears of a cone and F and G are two eccentric gears of such diameter that two opposite points in their pitch circles osculate with the pitch circles of the adjacent working gears. When it is desired to change the intermediate gear, I, from one step to another, it is shifted sideways onto the translating gear when the cone reaches those critical points where the pitch circles of the working gear and translating gear osculate. Then when the translating gear has revolved 180 degrees, gear I is again moved sideways so that it comes into full mesh with the gear with which it is desired to work.

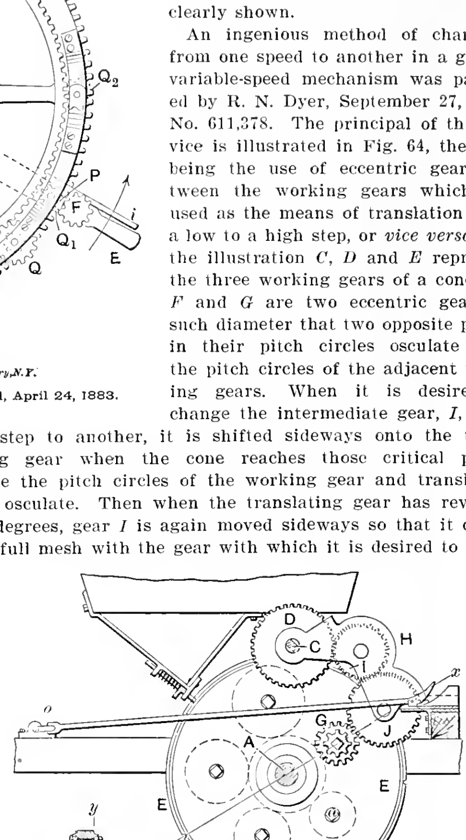

Fig. 63. Patent No. 307,002, granted to H. Bickford and A. Armitage, October 21, 1884.

The means of holding gear I in proper relation to both the working and translating gears is also shown, consisting of the friction roller L that is mounted on a curved arm forming a part of the arm carrying gears K and I. Friction roller L is always in contact with one of the wheels C_1, F_1, D_1, G_1, E_1, which coincide in diameter and relative position to the pitch

circles of the respective gears. The tendency of the gear *I* to throw out of mesh with the working gears holds the roller *L* against the face of the respective wheel corresponding with the gear with which it is required to work. The mechanism by which the changes are made at the critical periods in the rotation of the gears is not clearly shown in this cut, and being unnecessary for the purpose of illustrating the principle, the drawing showing this is omitted. It will be observed that a valuable feature of this invention is that the change from one step to the next is effected practically without shock, the eccentric gears acting as fairly efficient accelerating or de-accelerating devices.

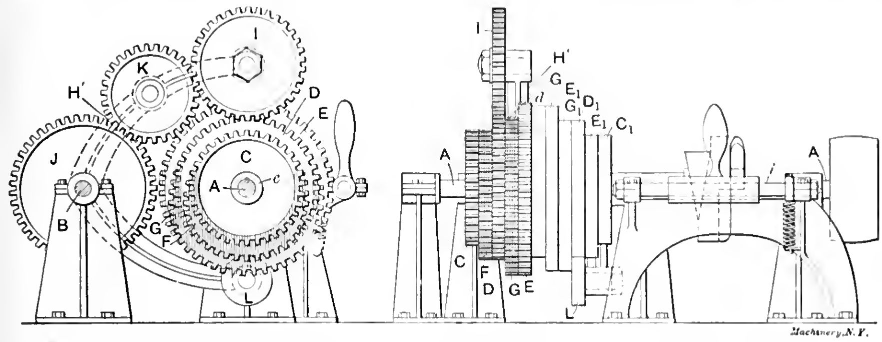

Fig. 64. Speed Changing Device for which Patent No. 611,378 was granted to R. N. Dyer, September 27, 1898.

* * *

A NOVEL WATER HOIST.

At the last meeting of the American Society of Mechanical Engineers, held at Scranton, Pa., a great deal of interest was evinced by the visiting members in the large mine water hoist recently erected at one of the Lackawanna mines at Scranton. The question of unwatering a mine is a serious problem in mine management, especially when the water is impregnated with acids. In the anthracite regions there are mines in which, for every ton of coal raised, as high as 14 tons of water must be pumped. Nowhere, probably, have a greater variety of pumps and lifting devices been tried, and the most satisfactory type, up to date, for handling large quantities of water at comparatively low heads, has proved to be large bailers operated by steam engines. These, however, lack the mechanical regularity of pumps, as they are necessarily operated by men.

The novelty of the new water hoist at Scranton lies in the facts that it is motor driven and that the raising and lowering of the buckets is entirely automatic and occurs at regular intervals, so that the raising of the water is carried on as uniformly as when pumps are employed. The apparatus constitutes what is probably one of the largest automatic machines in existence. Mr. H. M. Warren, electrical engineer of the Lackawanna Railroad, is primarily responsible for the arrangement, but the apparatus was built and the mechanical details carried out by the Wellman-Seaver-Morgan Co., Cleveland. Most of the electrical controlling devices were furnished by the Electric Controller & Supply Co. The specifications called for the hoist to be operated by an alternating-current motor of 800 H. P. and the question of starting, stopping, and reversing so large a motor had to be met at the outset. The duty to be performed by the hoist called for the raising of 1,000 gallons of water per minute to a height of 550 feet, which, with the work necessary to raise the rope and buckets, necessitated 610 net horse power.

It was decided that it would be impracticable to do other than run the motor continuously in one direction, as it is a well-known fact that the amount of current required to accelerate a large motor of this type is enormous, and greatly interferes with the running of the power plant. This, therefore, necessitated the use of friction clutches for accelerating and reversing the load, and this was the method followed.

Figs. 1 and 2 show a front and side view of the hoist. As will be noticed, the general arrangement consists of a motor driving a pair of bevel wheels through a single bevel pinion. The bevel wheels run loose on a shaft and are fitted with the well-known Webster, Camp & Lane friction clutches. The operating mechanisms for the clutches are so designed that only one clutch can be thrown in at a time, but both clutches can be out at the same time. Throwing in one clutch runs the drum in one direction; throwing in the other clutch reverses the motion of the drum.

To the shaft on which the bevel wheels run there is keyed a pinion meshing with the main gear on the drum shaft. The drums are 10 feet at the small diameter and 16 feet at the large diameter. There is one main brake located between the drums. All of the clutches and brakes are operated by auxiliary air cylinders fitted with oil cushion cylinders, the compressed air being furnished by a motor-driven air compressor and the necessary tanks located near to the hoist.

The hoist is controlled by a mechanical device shown in Fig. 2. The periods at which this device must operate are, of course, when the buckets are full up and full down, at the end of their travel in each case. To set the controlling mechanism in operation at these times there is a traveling nut which moves along as the drums rotate, and at each end of its travel this nut releases a stop and allows a friction-driven controlling drum to make a quarter turn. This drum is rotated through a friction connection with the motor and the sprocket chain appearing at right in Fig. 2.

This quarter-turn movement of the controlling drum operates solenoids on the clutch valve, through suitable electrical connections, and releases the clutch, and the solenoid on the brake valve sets the brake. At this point a stop which prevented the friction drum from making more than a quarter turn is now moved by the motion of a secondary shaft, timed to the interval required to empty the bucket. This releases

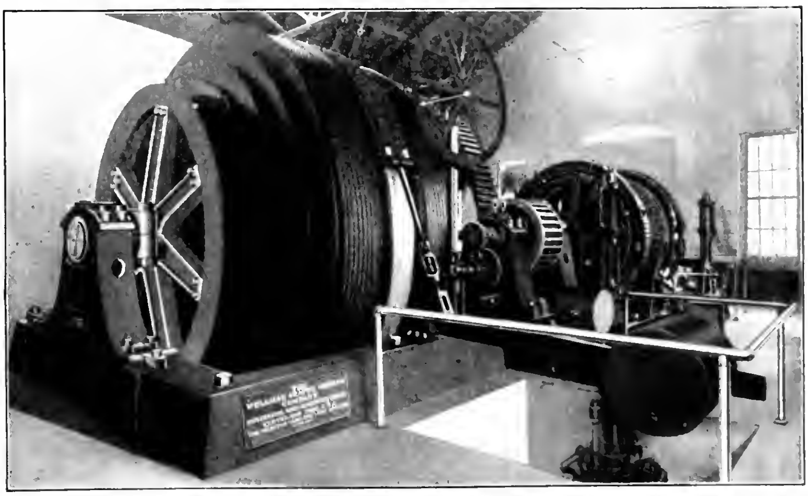

Fig. 1. Side View of Winding Mechanism of Lackawanna Water Hoist.

the controlling drum and as it continues to rotate it releases the brake and throws in the reversing clutch, thus starting the hoist in the opposite direction, and also starting the traveling nut of the controlling mechanism in the opposite direction.

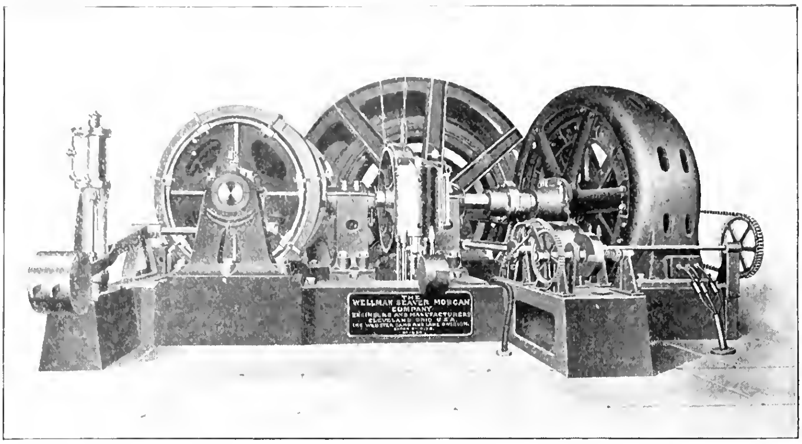

Fig. 2. Front View of Winding Apparatus showing Controlling Mechanism.

If, for any reason, either the supply of current or of air pressure is interrupted, the valve drops, and the weights on the brake lever set the brake. The clutches are designed so that they are thrown out by the weights. As is the case with the brake, either clutch can only be thrown in when the current is on the solenoid, and the air pressure admitted under the piston, and if either current or pressure fail, the clutch is off. The motor shaft is fitted with an emergency brake operated by a weight controlled by a solenoid—any interruption in the flow of current to the motor sets the brake and stops the machine, throws out the clutches and puts on the brake. A safety cutout is provided for in the head frame so that in case a bucket is carried beyond the proper height, the current is cut off.

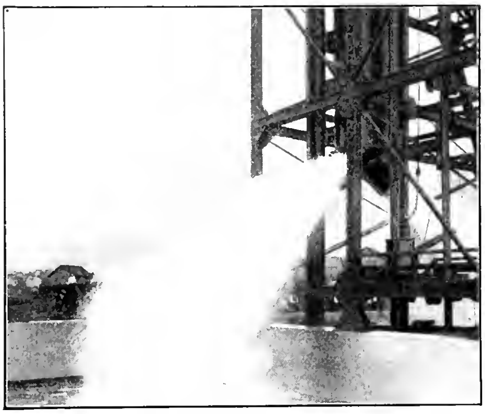
Fig. 3. Bucket Discharging.

Fig. 4 shows the head-frame. This is 93 feet from the base to the center of the sheave at the top. It is built of structural steel, roughly in the shape of an "A." From the head-frame are suspended two buckets 6 feet in diameter and 19 feet 6 inches deep. The capacity of each bucket is 17 tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross section of the bucket. These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, and which deflects it to either side of the shaft. Each bucket makes a complete round trip in one minute and fifty seconds, the total lift being 555 feet.

Fig. 3 shows a nearer view of the bucket when discharging.


Fig. 4. Head Frame at Mouth of Water Hoist Shaft.

* * *

MEETING OF THE AM. SOC. OF MECHANICAL ENGINEERS.

The fifty-second meeting of the American Society of Mechanical Engineers will be held in New York city during the first week in December. The headquarters instead of being at the society house, 12 West 31st Street, as in previous years, will be at the Edison building, 44 West 27th Street, the two upper floors being used.

The opening session at which President John R. Freeman will present the annual address will be at 44 West 27th Street on Tuesday evening, December 5. The second or business session will be held Wednesday morning in the main saloon of the steamship "Amerika" at the docks of the Hamburg-American Line at Hoboken, N. J. Following this session a special train will take those desiring to make the excursion to the new Henry R. Worthington Hydraulic Works at Harrison, N. J. Wednesday evening there will be an illustrated lecture at 44 West 27th Street by Prof. R. W. Wood of Johns Hopkins University on Photography of Invisible Phenomena. The third session will be on Thursday morning at 44 West 27th Street and besides the presentation of professional papers there will be a discussion on the subject of "Bearings."

Thursday afternoon there will be a reception at the New York School of Automobile Engineers, 146 West 56th Street. The usual reception at Sherry's will occur on Thursday evening. The closing session will be at 44 West 27th Street on Friday morning and will be devoted to the presentation of professional papers.

Manchester he gathered young men from all over New England, taking the young blacksmith from his cross roads forge, the wheelwright from his village shop, and the farmer boy from the corn field, and training them to become intelligent, enthusiastic workmen, many of whom in later years rose to positions of fame and responsibility.

William Bement, who founded the firm of Bement, Miles & Co., was one of these young men. He was a blacksmith in Peterboro, N. H., before he went to work in the Manchester shops. Hugh R. Garvin, the founder of the Garvin Machine Co., was another man who came under Mr. Burke's influence. Mr. Hildreth himself owes much to this trainer of young mechanics.

By the year 1845 work had slackened up at the machine shop in Lowell, so the Proprietors of Locks and Canals sold it to Abbott Lawrence and others, and the business took the name of the Lowell Machine Shop, under which it has ever since been run. At Mr. French's suggestion the management of the shop was turned over to Mr. Burke, who came down from Manchester for that purpose, and he continued as its superintendent until 1862, when he left to take an active interest in the cotton mills of the city. Later on, in the seventies, he was again connected with the shop in the capacity of Treasurer, and under his administration the Lowell machine shop became the greatest builder of textile machinery in the country. From 1879 until his resignation a few months ago Mr. Hildreth has been the superintendent.

What has been said about these shops at Lowell, Manchester and Nashua, applies equally well to other mill centers all over New England. The birth of the machine shop in this part of the country was in the repair shop of the cotton mill. F. C. Pratt learned his trade in the "Aldrich Shop" in Lowell just across the way from the Lowell Machine Shop; Amos Whitney, who afterwards became his business partner, started life in the repair shops of the Lawrence cotton mill; and as to how many more of these men there may be who started their lives in a like fashion I do not know, but the cotton mill repair shop was evidently a fertile field for the growth of the pioneer American mechanic.

* * *

THE "GLOBOID" WORM DRIVE.

ROBERT GRIMSHAW.

The cuts show a new drive which has had well deserved success in Germany, and for which is claimed not only 90 per cent of useful effect but that it preserves its efficiency during a longer time than either the ordinary worm or the spiral gear drive. As will be seen from the illustrations, there is a worm in connection with a worm-wheel, but instead of the teeth of the latter being immovable, each consists of a truncated cone turning loosely upon an axis radial to the worm-wheel. The worm is of the hour-glass type. The combination of the hour-glass worm and the rolling teeth is what accounts for the noiseless working observed and the small loss of efficiency experienced. The conical rolls are mounted on hardened steel pins. Screws, washers, and other small parts which would increase the cost and diminish the efficiency, are avoided. In proof of the high efficiency of these worms, the wheel can run down the worm, even when the latter is single-threaded. For this reason the maker claims that the drive is specially adapted to automobile service. There are made

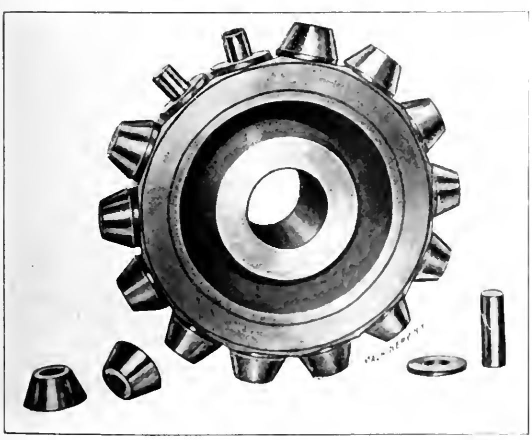

Fig. 1. "Globoid" Worm Drive, with Cover removed.

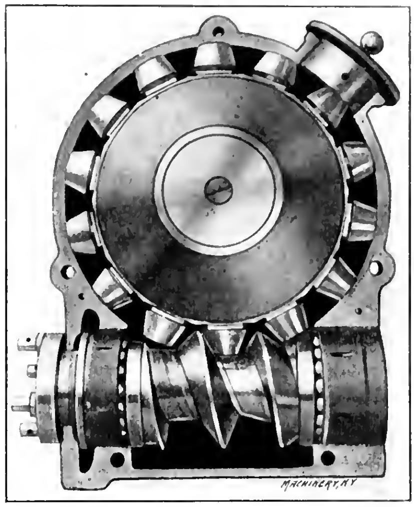

Fig. 2. Construction of the Wheel.

eleven different sizes of one of the types, with capacity up to 500 H. P. with 75 turns per minute of the worm-wheel and a velocity ratio of 10 to 1. In this case the turning moment on the wheel shaft is about 7,500 foot pounds. The velocity ratio can be anything from 2 : 1 up to 30 : 1, or with double reduction by means of two sets from 32 : 1 up to 1,000 : 1. As a rule the worms are single threaded, but there are cases, especially where the velocity ratio is below 8 : 1, where more

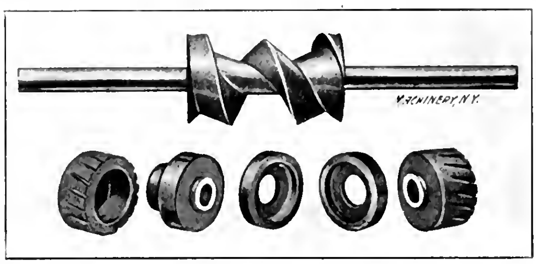

Fig. 3. The Worm and its Bearing

threads are used. The entire casing is in two parts, as far as possible similar, bolted together so as to be oil- and dust-tight—a fact which very much facilitates the mounting and reduces the wear. Below the worm there is an oil chamber, in order to give the lubricant as much cooling surface as possible. The worms are of hardened and ground steel and run in phosphor-bronze boxes, while the end thrust is received by ball bearings. As these bearings are at both ends, the drive is adapted to both right-handed and left-handed connections. They also, as well as the cylindrical bearings, are adjustable, so that the worm can be adjusted axially.

The journals of the worm-wheel run in most cases in concentrically adjustable bearings, and their axial pressure is received by hardened and ground washers. The conical roller-teeth or tooth-rolls are of tough case-hardened cast steel, ground to the exact diameter. The rolls themselves are made of material selected for the particular service for which they are destined. It is claimed that with this style of toothed gear smaller diameters are practicable than in the case of the usual type. This, of course, means smaller casings and less weight. The maker is Hermann Pekrun, Coswig, Saxony.

TECHNICAL READING AND FORMULAS.—3.

C. F. BLAKE.

GRAPHICS.

The reader of technical literature will often encounter problems solved by what are known as graphical methods. All arithmetical calculations may be represented by drawings, and this is precisely what the many charts seen in the technical papers are, drawings of formulas.

To draw a formula we must first be able to draw the four arithmetical processes, addition, subtraction, multiplication, and division.

Addition.—Let it be required to add graphically 2 and 3, that is, to draw, the formula $x = 2 + 3$ and find the value of x from the drawing. In Fig. 11 draw line a-b two inches long, then commencing at b draw line b-c three inches long, which

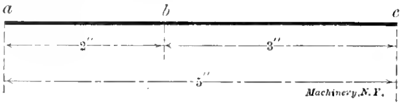

Fig. 11.

shall be a continuation of line a-b. Line a-c now measures five inches, therefore $x = 5$, and a-c is the drawing of the formula.

Subtraction.—It is evident that subtraction will be the reverse of addition. Let it be required to draw the formula $x = 5 - 2$. Using the same figure as above, draw line a-c five unit, but let this unit be that from 1 to 2. Then the horizontal and vertical lines will be of the same length. Mark the horizontal scale 0 to 1, the vertical scale 1 to 2, and the diagonal line 1.

If now we begin at 1 on the horizontal scale, and travel vertically to the diagonal line at A, we have gone one unit, and if from here we travel horizontally to the vertical scale, we will travel another unit, or two units altogether. Then the line 1-A-2 represents the drawing of the formula

$$x = 1 + 1,$$

but since the line has been bent from the form of a straight line, we are no longer able to measure anything to obtain the answer. We do not need to do this, however, since we land at the figure 2, which is the answer. The operation has been made plain by the full arrows marked +. The reverse operation, subtraction, is shown with dotted arrows marked —, and the line 2-A-1 is the drawing of the subtraction formula,

$$x = 2 - 1,$$

and beginning at 2 we end at the figure 1, which is the answer.

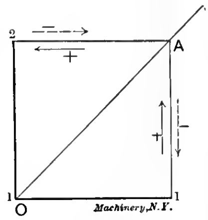

Fig. 12.

More diagonal lines may be drawn from points representing more units in the vertical direction, and thus we arrive at an addition and subtraction diagram, which may be made to cover any desired range of problems.

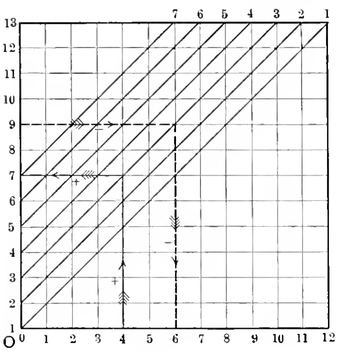

FIG.13

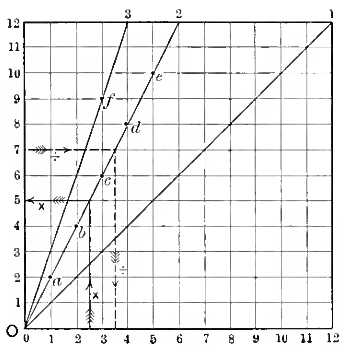

FIG.14

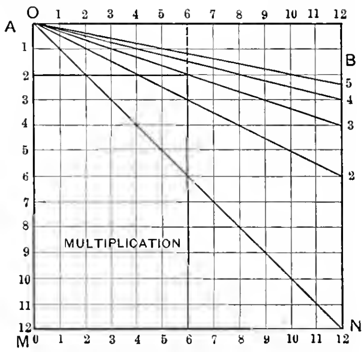

FIG.15

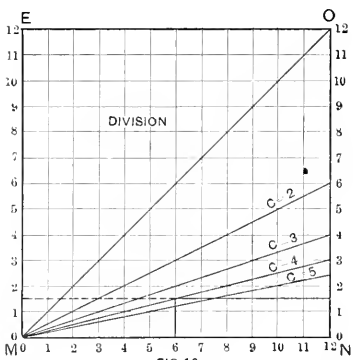

FIG.16

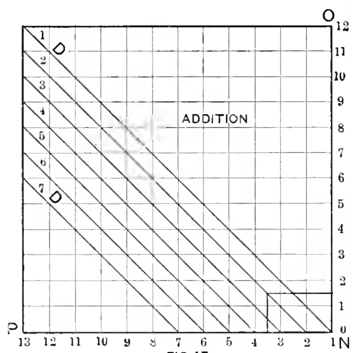

FIG.17

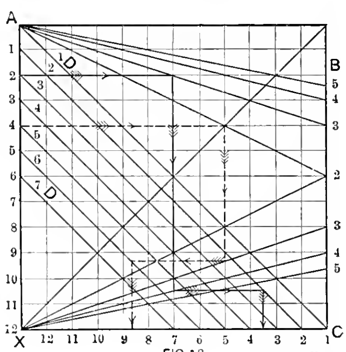

FIG.18

inches long, and from one end, a, lay off a-b two inches long. Then b-c measures three inches, and $x = 3$, and a-c is the drawing of the formula.

The unit of measurement, here taken as the inch, may be any length convenient so long as all measurements are made to the same unit.

The drawing of the addition and subtraction formula as given above applies only to its individual problem, and since the number of problems is infinite, and even within the range of every-day practice is very great, some form of drawing which may be used for a great number of problems, is needed. In Fig. 12 draw two lines at right angles, and draw the diagonal line at 45 degrees. Let the horizontal line represent one unit, from 0 to 1, and let the vertical line also represent one unit, but let this unit be that from 1 to 2.

Fig. 13 represents such a diagram. The full line and arrows represent the problem,

$$4 + 3 = 7,$$

and the dotted line and arrows represent the problem

$$9 - 3 = 6.$$

Multiplication and Division.—A similar diagram to the above may be made for multiplication and division, as shown in Fig. 14.

Lay out the horizontal and vertical scales equal, each starting from the zero point (observe the difference between the two diagrams in this respect). Draw a 45-degree line from the zero point, and mark the line 1. If we start with either scale and travel to this diagonal line, and then to the other scale, we arrive at the same figure we started with, or in other

words, we have either multiplied or divided our starting figure by 1. Start now at 1 in the horizontal scale and travel vertically till opposite 2 in the vertical scale, marking this point a. Start again at 2 and travel till opposite 4, and mark the point b. Start at 3 and travel to 6, at 4 and travel to 8, and at 5 and travel to 10, marking the points c, d, and e. We now find that the points a, b, c, d, e, and the zero point are all in line; also that in starting at 2 and going to 4, etc., we have multiplied each of our starting points by 2. Draw a line through these points and mark it 2. Since the points are all in line, it is unnecessary to locate more than one to locate the line. Start at 3 and travel till opposite 9, and mark the point f. Connect f and 0, and mark the line 3, because $3 \times 3 = 9$, and we have multiplied our starting figure by three to locate f opposite 9. In this way as many other lines may be located as desired.

The full line marked $\times$ is the drawing of multiplication formula,

$$x = 2\tfrac{1}{2} \times 2 = 5,$$

and the dotted line marked $\div$ is the drawing of division formula,

$$x = \frac{7}{2} = 3\tfrac{1}{2}.$$

A set of such charts may be made for any formula, no matter how long, by making a chart for each step or arithmetical process in the formula. These separate charts may usually be combined into one with advantage. Figs. 15, 16, 17, and 18 represent such a series of charts and their final combination into one chart for the formula,

$$x = \frac{A\,B}{C} + D.$$

Let $A = 2$
$B = 3$
$C = 4$
$D = 2$

The first chart, Fig. 15, solves the first step, the multiplication of A and B. Values of A are first laid off vertically on the right, and at the top and bottom horizontal scales are laid off. The B lines are then drawn in, as in the previous multiplication chart, by assuming various values of A and B, and locating their proper points in the chart, as $A = 2$ and $B = 3$, $A \times B = 6$; through the intersection of lines from 2 and 6 draw 0-3, which is the line for $B = 3$. Draw lines for other values of B in the same manner. We find it possible to read the answer either at the top or bottom scale, and for the present we leave this question open.

The next step is to divide the product of A and B by C. In Fig. 16 lay off scale $M\,N$ exactly like scale $M\,N$ in Fig. 15. Lay off the two vertical scales, starting with zero at the bottom, otherwise exactly like the vertical scale in Fig. 15. Assume values for $A \times B$ and for C and lay off C lines as the B lines were laid off in Fig. 15.

We find we can read the answer either on the right or left, and leave the decision till later.

By multiplying A and B in the first chart, and dividing the product by C in the second chart, we have left only to add to the result, D, for the final step.

In Fig. 17 lay off scale $O\,N$ exactly like $O\,N$ in Fig. 16, and lay off scale $P\,N$ exactly like scale $M\,N$ in Fig. 15, but beginning with 1 at the right. Now draw an addition chart by assuming values for $A \times B \div C$, on scale $O\,N$, and values for D, and draw the D lines as described for the previous addition diagram.

By these three diagrams we can solve the equation,

$$x = \frac{A\,B}{C} + D,$$

if we have given values of A, B, C, and D. The process will be as follows: Find the value of A on scale $A\,M$, Fig. 15, and proceed horizontally to value of B, thence vertically, and read product of $A \times B$; find this product on scale $M\,N$ in Fig. 16, proceed vertically to value of C, thence to right and read value of $A \times B \div C$; find this value on scale $O\,N$, Fig. 17, and trace to left to value of D, thence down to value of

$$\frac{A\,B}{C} + D = x$$

and read the answer.

It is a great inconvenience to have to jump from chart to chart, and it may be easily avoided. If these charts were drawn on tracing paper, and placed one over the other, we should find that their lines are all clear and distinct, and do not interfere with each other to the extent of losing their identity. This point was kept in mind when drawing the small charts; for example, in Fig. 16 the scales could be arranged so that the C lines would radiate from corner E, but they would then become confused with the B lines of Fig. 15 when the two are superposed; also in Fig. 17 the D lines could be drawn in the upper half by rearranging the scales, but they would then interfere with the B lines of Fig. 15 when superposed, while as drawn they appear in the opposite half of the chart from B lines, and they cross the C lines at such a great angle as not to become confused with them.

Fig. 18 shows the three charts drawn superposed one on another, and by inspection we see that it is no longer necessary to read the value of each step in order to take the next step, but that we can proceed from line to line, reading the value of each letter in turn, till we read the value of x at the bottom. The question left open as to which scales to read the answers on in Figs. 15 and 16 has solved itself in the superposed diagram.

The full line with arrows shows the working out of the same problem as the lines in the separate diagrams, namely, the value of x in the formula

$$x = \frac{A\,B}{C} + D$$

when $A = 2$, $B = 3$, $C = 4$, and $D = 2$.

Such problems as the following, and others, may be solved on this chart, and the reader should practice till he can solve such problems easily and quickly.

Shown in diagram in dotted lines.

$$\left.\begin{array}{l} A = 4 \\ B = 2 \\ C = 3 \\ D = 6 \end{array}\right\} x = \frac{4 \times 2}{3} + 6 = 8.6$$

$$\left.\begin{array}{l} A = 3 \\ B = 3 \\ C = 4 \\ D = 5 \end{array}\right\} x = \frac{3 \times 3}{4} + 5 = 7.25$$

It is in this manner that the charts we see in the technical journals, giving the strength of gears, shafts, etc., are worked out.

It often happens that it is necessary to vary the scales, also that in plotting out points, as a, b, c, etc., in Fig. 14, that the resulting line is a curve.

Such graphical processes as we have just been considering, and the laying out of charts is called graphical arithmetic. There is another branch of graphics called graphical statics, so frequently used as to demand a knowledge of its fundamental principles of any reader of technical publications.

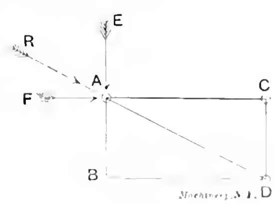

Fig. 19

In Fig. 19 let A be a small ball, and let E be a force acting on the ball, and just sufficient to drive the ball to B. Also let F be a similar force just sufficient to drive the ball to C. If the force E acts alone the ball will start and travel A-B and come to rest at B, while if the force F acts alone the ball will travel A-C, and come to rest at C. Now, suppose that both forces act at the same instant. We would expect the ball to partake of motion resulting from each force, and to travel to the right at a distance A-C, and also to travel downward on the page a distance A-B, and this lands the ball at D. It cannot, however, travel either the path A-C-D or A-B-D, because it partakes instantly of motion from each force, and it can only travel A-B or A-C under the influence of one force acting alone. We will also assume that the ball must travel in a straight line, because to cause it to travel in a curved line we should have to introduce a third force in the shape of guides or other device, and we are supposing the ball to be acted on only by the forces E and F.

Therefore, since it must travel a straight line, must land at D, and cannot travel either A-C or A-B, it must travel A-D.

It is obvious that we could easily move the ball from A to D by a single force acting in the direction of A-D, and just strong enough to move the ball and bring it to rest at D. Such a force would be the force R, shown in dotted lines in Fig. 19. There are formulas involving the trigonometrical functions, by which, knowing the force and direction of both E and F, we may find R, but it is more simply done by the following method:

Adopt some convenient scale of force, as one inch equals ten pounds. Along A-C lay off by this scale the force F; that is, if F is fifteen pounds, make A-C one and a half inches for the above scale. Lay off on A-B the force E in the same manner and to the same scale. Now complete the parallelogram by drawing B-D parallel to A-C, and C-D parallel to A-B. This is called the parallelogram of forces. If, now, we measure A-D by the force scale adopted, we find R. Thus, if with the above scale, A-D measures two inches, then force R is twenty pounds.

This force R is called the resultant of forces E and F, and the latter are called the components of R. By a little study of the figure it will be seen that the problem may be worked backwards, or that a given force R may be divided into two other forces at will. This process we call the resolution of forces, and we say that any force may be resolved into its components.

Now, experiment proves that the same thing is true when the forces act at any angle, as in Fig. 20. Now, suppose the ball acted upon by three forces, E, F, and G, the latter being shown in dotted lines in Fig. 20, and being such a force as acting alone would move the ball from A to H. Now, we know that E and F, acting together, move the ball to D, for we can locate D by drawing the parallelogram of forces, A-B-D-C, and A-D will be the resultant of E and F. Now, since any two forces may be replaced by their resultant, we may consider that the ball is acted on by only two forces, R and G. We may now draw another parallelogram of forces for G and R, being A-H-J-D, and the final resting place of the ball acted upon by the three forces E, F, and G will be J; also A-J will be the resultant of the three forces E, F, and G.

The observant reader will notice that it is not necessary to draw the entire parallelogram of forces in order to locate the ball, or the magnitude or direction of the resultant. Thus, we could draw A-C parallel to F, C-D parallel and equal to E, and D-J parallel and equal to G, thus locating J. Then, drawing J-A, we would complete a polygon, A-C-D-J, called the polygon of forces, and J-A is called the closing line, because it completes or closes the polygon.

Let us now suppose that, instead of being moved by the three forces, the ball remains at rest, but is still acted upon by the three forces, E, F, and G. We then say that the ball is in equilibrium, and this can only be true when some force acts counter or opposite to the resultant of the three forces. Such a counter force is called a reaction, and is represented by J-A.

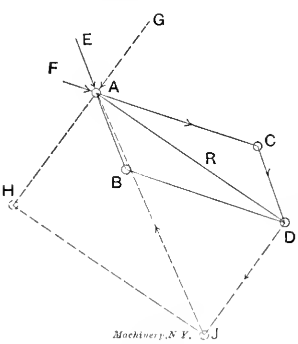

Fig. 20.

Let us now place upon each line, A-C, C-D, and D-J, an arrow corresponding to the forces F, E, and G, respectively, and we see that the arrows follow each other around the polygon; this must be so or the polygon is incorrectly drawn. Following this rule, and placing an arrow on J-A, we see the direction of the reaction that would keep the ball in equilibrium.

Since the three forces may be replaced by the resultant, A-J, and the reaction, J-A, keeps the ball at rest, we would expect: 1st, the line of the reaction to coincide with the line of the resultant; 2d, that the magnitude of the reaction and the resultant would be the same; 3d, that their directions would be opposite. This is precisely what the diagram shows because, 1st, the closing line of the polygon, J-A, has fallen upon the line of the resultant, A-J, of the three forces E, F, and G; 2d, the points A and J mark the ends of both the lines of the resultant and reaction; 3d, because the arrow placed upon the closing line in conformity with the other arrows points opposite to an arrow placed upon the line representing the direction of motion of the ball if no reaction were there.

The use of these principles of graphical statics may be well illustrated by the following example, Fig. 21. This represents a pulley or sheave, over which is passed a rope, on one end of which is a load, L, of 300 pounds. We know that, owing to the stiffness of the rope and the friction of the sheave pin, we must pull with more than 300 pounds on the other end of the rope in order to lift the load. Suppose we lose 10 per cent of our pull. We must then pull on the rope with a force, P, of 330 pounds to raise the load, L, of 300 pounds. Continue the lines of the rope to meet at b. Adopting a scale of 1 inch

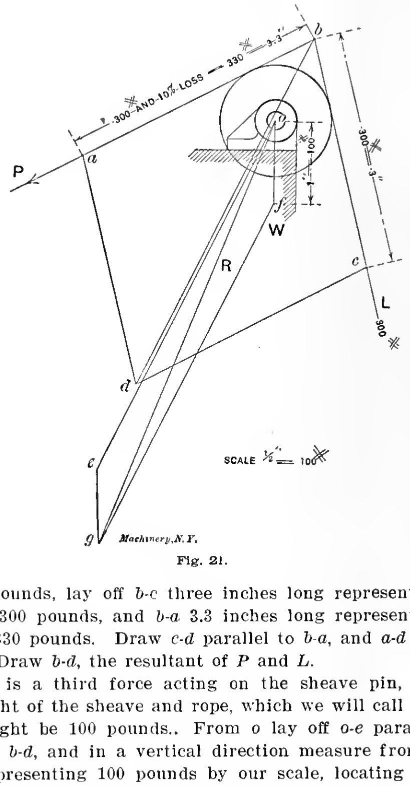

Fig. 21.

to 100 pounds, lay off b-c three inches long representing the load of 300 pounds, and b-a 3.3 inches long representing the pull of 330 pounds. Draw c-d parallel to b-a, and a-d parallel to b-c. Draw b-d, the resultant of P and L.

There is a third force acting on the sheave pin, namely, the weight of the sheave and rope, which we will call W. Let this weight be 100 pounds.. From o lay off o-e parallel and equal to b-d, and in a vertical direction measure from o one inch, representing 100 pounds by our scale, locating point f. From f draw a line parallel to o-e, and from e draw a line parallel to f, thus locating point g. Then will o-g be the resultant, R, of the load and pull on the rope and the weight of the sheave, and the reaction of the support must be in this direction. Thus we know on which side to cap the bracket, to make the base, etc.

If we measure the line o-g we find it is 5.83 inches long, and multiplying by 100, since one inch equals 100 pounds, we find the resultant force on the sheave pin is 583 pounds.

If we had not taken account of the stiffness of the rope and friction of the pin, and had assumed the pull, P, equal to the load, L, which, of course, it is not, the line b-d would have passed through the center, o.

* * *

Apparently a new kind of machine tool has been discovered by an English contemporary, being, according to its designation, a turbine planing machine. It, however, resolves itself into a large Richards type traversing head planer built for heavy steam turbine construction. This machine built by Geo. Richards & Co., Broadheath, England, will plane 25 feet long, and across the top of work 10 feet wide and on the side of work 8 feet wide. It is driven by a 40 horse power motor. Its weight is 50 tons and it is specially designed for taking heavy cuts at high speeds.

NEW LIVERPOOL AUTO FIRE ENGINE WITH LIQUID FUEL SYSTEM.

FRANK C. PERKINS.

A motor fire engine is in operation in Liverpool which possesses some novel points of interest. It is fitted with a liquid fuel system of firing, known as Kermode's system, and was constructed from specifications of Chief Thomas, of the Liverpool fire brigade, by Messrs. Merryweather & Sons, Ltd., Greenwich, London.

The accompanying illustrations show the details of the liquid fuel burner and its connections with the boiler of the fire engine, as well as the arrangement of the piping and firebox. A pipe leads steam from the boiler to the burner, the steam being controlled by a valve and the pressure at the burner being indicated by the gage, which at full load reads about 33 pounds per square inch with a boiler pressure of 100 pounds. The oil is supplied through a lower pipe to the burner, which weighs less than 10 pounds and has an extreme length of less than a foot, one burner only being fitted to the firebox. The steam atomizes and heats the oil, driving it into the firebox along with a large amount of air, on about the same principle as an injector. The usual firebox has been deepened, a steel plate 1/8 inch in thickness being added with a lining of fire brick 1.5 inch in thickness. The bottom of the firebox is provided with a steel plate 5-16 inch in thickness in place of fire bars, this plate being drilled with holes 7/8 inch in diameter. The oil gravitates to the burner, although should it be necessary the burner by its action is capable of lifting the liquid fuel to a height of 24 inches.

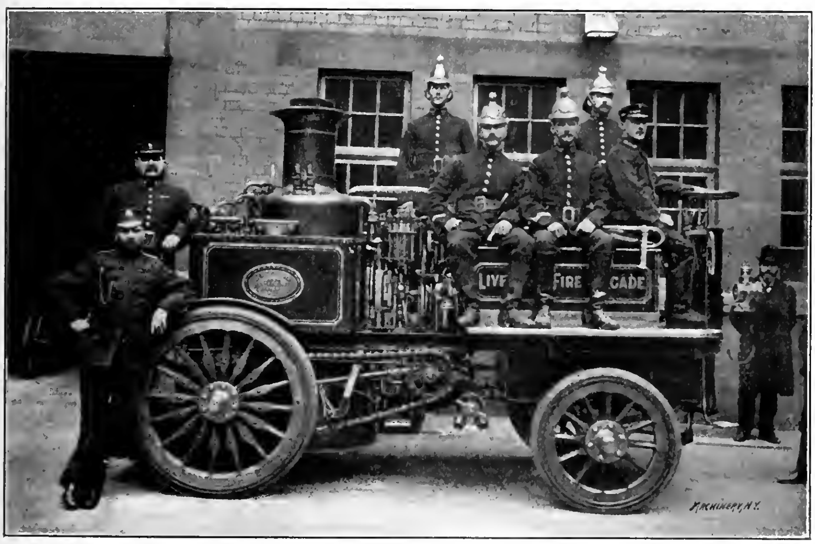

Fig. 1. The Liverpool Oil-burning Automobile Fire Engine.

The Liverpool self-propelled fire engine has a steam motor of 50 horse power capacity which may be used as a pumping engine or as a chemical engine, with a capacity for throwing 500 gallons per minute in from one to six streams over the highest buildings, and is fitted with a sixty-gallon chemical cylinder. It carries 1,500 feet of hose with the necessary attachments for water mains, together with a Pompier ladder for scaling high buildings. It also carries eight firemen and one officer and sufficient oil for operating the engine about five hours, both for propelling the vehicle and for steam-pumping purposes.

Two auto steam motor fire engines have been on constant duty with steam up for one and two years, respectively, and there is also in operation a horse-drawn portable air and electric light engine fitted with the Kermode burner, this outfit being kept constantly under steam. The dynamo is mounted on top of the vehicle and supplies current to a number of incandescent lamps fitted with handles and wire guards and connected to flexible cables of considerable length on reels.

While the fire engine is not in use a pressure of 80 pounds of steam is kept up by a gas burner in the firebox, and when a fire alarm is given the gas burner is withdrawn, the oil is supplied to the burner, and the fire engine is ready for service. By this arrangement 30 seconds only are necessary for the engine to start. It can easily make a speed of 20 miles per hour through the streets and thus reach the fire before the horse-drawn fire engines. It is claimed that no smoke is thrown from the stack nor fuel dropped on the way, and the engine has been in operation a number of months without the boiler tubes being cleaned or the burner requiring inspection.

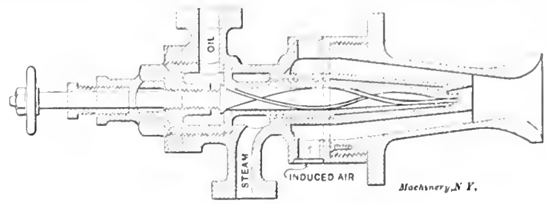

Fig. 2. Sectional View of Liquid Fuel Burner.

If it is found that the fire is of small dimensions, as three-fourths of the Liverpool fires are, the chemical engine is used, and the hose carried on the fire engine is employed. If, however, it is a serious fire, the pumping engine with six lines of hose attached is brought into service. By combining these various elements in one machine, therefore, one engine is capable of performing what formerly required three fire vehicles to accomplish.

For country fire stations this latest addition to fire brigade equipment ought to prove a boon, as the air or gas charge will last for any length of time, and when a fire call is made the charge is brought into operation at once and steam raised with oil fuel on the way to the fire. The entire absence of hand stoking allows the firemen to be engaged in the work of salvage in fighting the fire.

Oil fuel has many advantages over coal and wood for fire engine work, being clean and smokeless, with no sparks or soot deposit. It results also in even steaming, automatic stoking and economy in managing the engine, while the steam can be rapidly raised, lowered or stopped as desired, constituting an important feature. The failure of a feed pump or injector might result in a calamity where coal is used as fuel, but where liquid fuel is used the fire is under constant control. By the use of liquid fuel it is not necessary to reinforce the fuel supply of the engine, in the way in which it has heretofore been found needful with the coal fire engines, unless the fire is a very long and stubborn one.

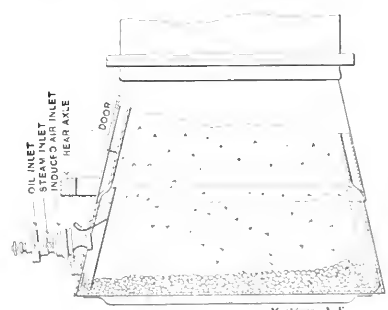

Fig. 3. Arrangement of Burner and Fire Box

MILLING MACHINE FIXTURES.—2.

E. R. MARKHAM.

There are many pieces of work that can be machined at a much less cost if a fixture specially designed for the purpose is used. When the number of pieces to be done warrants the outlay, it is generally advisable to pursue this policy. There are other pieces of work that must be held in specially designed fixtures, in order to produce a sufficient degree of accuracy, and there are still others that cannot be machined unless such fixtures are provided. The design of such fixtures should always depend on the number of pieces to be machined, and the cost of doing the work. If a fixture is to be used for machining a relatively small number of pieces, then it should be made at as small a cost as possible. If, on the contrary, it is to be used as a permanent fixture for machining the same class of work for an indefinite period, then it should be made in a manner to insure its "standing the racket." Such fixtures should be made very strong and solid, as the cost for stock and labor is not much greater than when making a light, "shifty contraption."

As cast iron is the material used for the base of most fixtures of this kind, plenty of the material rightly distributed will insure freedom from chattering and uniformity of the product, provided other conditions are right. This additional weight of cast iron does not materially add to the cost of the fixture. As a rule cast iron does not prove satisfactory as a surface against which to bed small pieces when milling, and for this reason a surface of steel is generally provided for this purpose.

Fig. 11 shows a milling machine fixture used for milling a leaf for a Vernier rifle sight. It is necessary to have the sides *a a*, of the leaf parallel to the sides of the slot. The base, *b*, of the fixture is made of cast iron, the bottom of which is

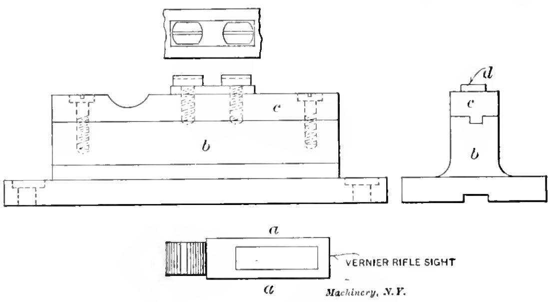

Fig. 11. Fixture for Milling Rifle Sight.

planed flat. It has a slot cut in it to receive the tongue pieces which fit a tongue slot in the table. A groove is cut in the top surface to receive a tongue on the steel portion, *c*. This is attached to the base by means of screws, after which the projection *d* is milled in the machine the fixture is to be used on. This insures perfect alignment between the sides of the tongue, *d*, and the table travel, and in consequence the sides of the leaf are exactly parallel to the walls of the slot when the pieces are milled. In the case of this particular piece of work it was found necessary to provide a somewhat complicated contrivance to hold the leaf down onto the fixture while milling, as the cut was rather heavy, compared with the strength of the sides of the leaf. But it occurred to us that by reversing the cutters and running them down onto the work, rather than against it, the cutters would be made to hold the work down onto the seating of fixture rather than to tend to raise it. All that was needed then was two screws, the heads of which screwed down onto the leaf. To release the leaf it was necessary to give the screw but a quarter turn as the opposite sides were cut away to a width a trifle less than the width of the slot in the leaf. The only reason it was necessary to provide the screws was that at the ends of the cut the pressure of the cutters tended to tip the leaf.

In order to produce good work when straddle-milling on a single-spindle milling machine, it is necessary to have the table travel exactly at right angles to the axis of the spindle. Should it not do so, it will be necessary to either scrape the saddle or swivel the head to get the alignment. The Lincoln type of miller usually has provision for the latter adjustment, but if not, and the saddle must be scraped, it is better to scrape the sliding surfaces which bear against the bed, instead of the table slides, unless the latter should be so badly worn as to need scraping.

The alignment of the saddle of a milling machine may be tested by means of a piece of wire attached to the spindle, as in Fig. 12. In this case the bearing surface to be tested is on a bevel, instead of standing vertical, and so a cast-iron block is planed to fit the angle portion, the block having a vertical surface for the point of the wire to bear against.

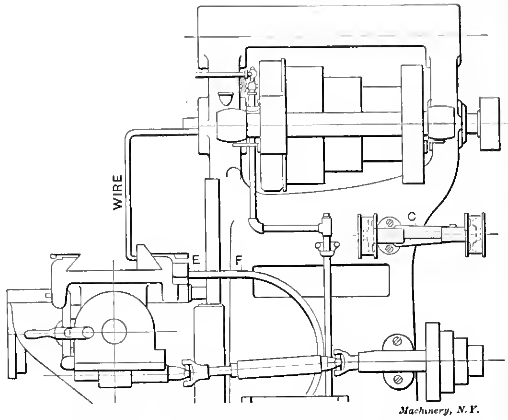

Fig. 12. Testing the Alignment of the Milling Machine Saddle.

Fixtures are many times made to hold two or more pieces of work to be machined at the same time, thus increasing the efficiency of the machine. Fig. 13 represents a fixture used in milling a bolt head flat on opposite sides. The fixture is designed to do away with any inaccuracy that might result from an attempt to mill bolts whose bodies were of varying sizes. For this reason the grooves for holding the bolts are made V-shaped instead of circular. The fixture is so designed as to allow the strain incident to cutting to come against the solid part of fixture. To insure ease of manipulation, the cam levers, used in clamping the pieces in the fixture, are located in the portion of fixture nearest the operator. Were they located on the opposite side it would be necessary to run the table back far enough to get the cam levers away from the cutters, so as not to endanger the operator's hands. Then again, if located nearer the cutters, they would be covered with chips, thus rendering it necessary to clean them every time before handling. The designer should always have

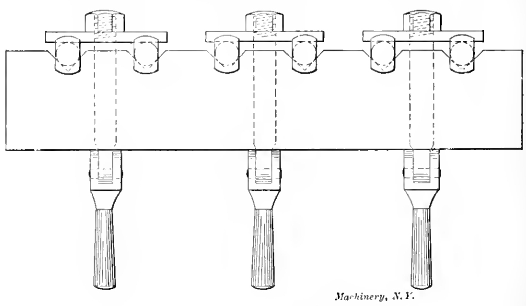

Fig. 13. Fixture for Flatting Bolt Heads.

in mind the safety of the operator, not only from a humanitarian standpoint, but also because accidents caused through poorly constructed tools and appliances are extremely costly to the manufacturing concern in whose shops they happen. I have known one such accident to cost a company more than all the tools they would make in a year, and a little forethought would have averted it.

It is generally better practice to have the device used in holding the piece of work to the fixture connected with that part which holds the work, as shown in Fig. 14. If this plan is adopted there is no danger of springing the fixture and

thus producing work which is not uniform to gage, as might happen if the design shown in Fig. 15 were used. If the fixture is extremely heavy and there is a certain amount of error allowable in the gaging, the objection to the method shown in Fig. 15 would not be readily apparent. However, for accurate work it is advisable when possible to adopt the method shown in Fig. 14, for it is possible to spring fixtures which are apparently quite strong.

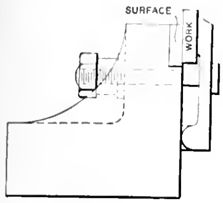

Fig. 14

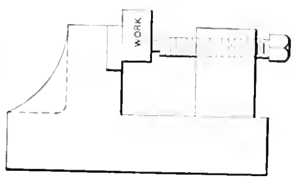

Fig. 15

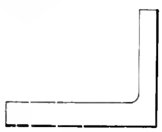
Fig. 16


Fig. 17

Points in the Holding of Work to Prevent Springing.

If a fixture is to be made in the form of an angle iron and considerable strain is to be exerted by the operation of cutting, the upright portion of fixture should be made heavy, so as to absorb vibration, and it should be well braced on back to prevent any tendency to yield under the strain. If such a fixture were made as shown in Fig. 16 the piece of work being machined would be chatter-marked from the vibration, and out of true from the yielding of the fixture. If it were made as shown in Fig. 17 neither of these troubles would be experienced, provided other conditions were right.

When possible always have the pressure of the cutter against the solid part of the fixture as shown in Fig. 18, rather than against the holding device, as in Fig. 19.

If you are called to design a fixture for holding work on a milling or other machine, bear in mind this fact: The simplest fixture that will hold the work in a satisfactory manner

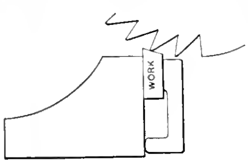

Fig. 18.

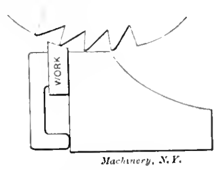

Fig. 19.

Proper and Improper Direction of Cut.

is as a rule the most satisfactory, to say nothing of its lower cost. It is necessary at times, in order to accomplish a certain purpose, to make a complicated fixture, but the more complicated such a tool is the greater the probability of its getting out of alignment and out of working condition. There is a tendency on the part of many young designers to make elaborate fixtures, not realizing that true success in this branch of business depends on making all machines and tools in the simplest way possible. To be sure, most of the automatic machinery on the market is very complex in design, but the designer uses every effort to simplify where possible and still have it accomplish the desired result.

While it is absolutely necessary that milling machine fixtures be made in a manner that insures the desired degree of accuracy, yet they should be so designed that the work may be placed in and taken out in the shortest space of time possible, since this item adds very materially to the cost of the article. As it is customary to have the operator run several machines, the greater the length of time necessary to devote to one machine, the fewer machines he can tend.

So far as possible always work to, or by, a given surface, or other working point. Do not change and work from a different one unless compelled to do so, as any slight inaccuracy that in itself might be of little consequence might affect other vital portions. This same principle should apply to all machining operations.

As an example of what has just been written, let us consider the cutting plier jaw shown in Fig. 20. This jaw was first forged to shape from tool steel under a drop hammer The side marked *a* was milled first, after which the opposite side was milled. Unless great care were taken when seating in the jaws the second side milled would not be parallel with the first. Now, this would not materially affect the finished jaw if one particular side were selected and worked to throughout the various milling operations. The surface *a* was selected as the working surface and was the one placed against the working surface of the drill jig. Then under normal conditions the drilled holes would be square with the surface worked from. The same side was also placed against the stationary jaw in milling machine vise when milling the surfaces *c* and *d*.

Then, if the jaws were properly made and set in the vise and reasonable care taken to prevent the presence of chips and dirt, the surfaces *c* and *d* would be square with *a*. The operations were afterward changed so the sides *a* and *b* were straddle-milled, but the first method of machining serves to illustrate the idea I wish to bring out.

A simple method I have used when necessary to mill a block perfectly square is to straddle-mill two sides as shown by hold-

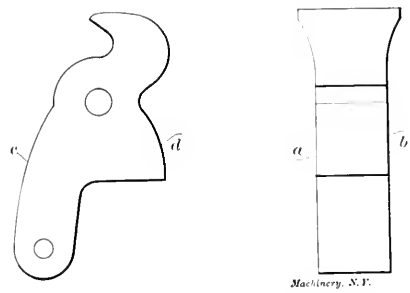

Fig. 20. Cuts taken in Finishing Drop Forged Jaw.

ing the block in the jaws of a milling machine vise. The other sides were straddle-milled also by holding the piece in the simple fixture, shown in Fig. 21, so designed that when the piece was fastened in the fixture, the tendency of the tightening device was to draw one of the sides that were milled at the first operation down onto the seating surface of the milling fixture as shown in Fig. 21. The tilting block *b*, bearing at the bottom tipped in such a manner when pressure was applied with the screw that it forced the work down onto the seating surface of fixture and back against the upright, etc. It might be found necessary when starting to use a fixture of this description to

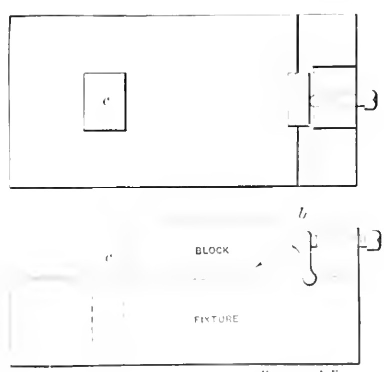

Fig. 21. Fixture for Straddle Milling.

block up under one edge with paper to bring the milled surfaces square with the seating surface, as the spindle and table of the machine might not stand exactly parallel. This must be ascertained by experiment. The parallelism of the two may be tested with a height indicator of the description shown in Fig. 22. However, if it is found necessary to raise or lower the machine the table may not stand in exactly the same relation to

the arbor as before moving. Then again the arbor may not be exactly true. All these things must be taken into account when testing machines for alignment.

I was engaged for a time in the manufacture of milling machines, and am free to confess that it is a problem, not always solved, to get a machine so trued up that it will show the same accuracy of alignment in one position as when the parts are raised or lowered or the saddle moved in or out. And an extensive experience in the production of work used in making guns, bicycles, knitting machines, and parts of machinery leads me to say that very few milling machines can be adjusted from one setting to another, and retain the same relative position of the various parts. To be sure they are correct enough for most

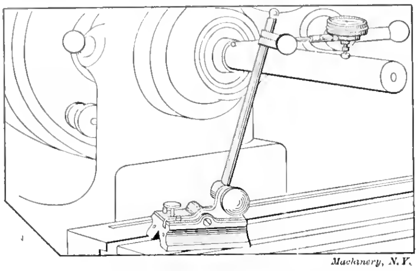

Fig. 22. Testing the Parallelism of Table and Spindle.

purposes, but when certain classes of work requiring an unusual degree of accuracy are to be done, it will be found necessary ofttimes to "shim" up under one edge of a fixture or else scrape a little stock from one portion of the seating surface, or in some way slightly alter the relative location of the arbor and seating surface.

Fig. 23 shows a bicycle hub having projections. Through these projections, or ears, are drilled holes to receive the spokes. Our equipment of milling machines was not sufficient to turn out the required number of pieces, and it was not deemed wise to increase our equipment, so we were compelled to devise ways of doing the additional amount of work on the machines we had. In order to accomplish this task, it was found necessary to make multiple fixtures.

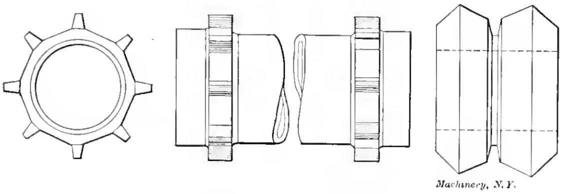

Fig. 23. Fig. 24.
A Bicycle Hub and the Cutter used in Making it.

Two fixtures were made to go side by side on a plate, each fixture to hold a hub. A dog was attached to one end of the hub, the tail of the dog entering an opening in plate on nose of spindle of the fixture. On the other end of the spindle was an index plate having around its circumference a number of holes equidistantly spaced, the number of which corresponded with the number of teeth to be milled on the hub. A hardened steel pin entered these holes and so located the hub. In making fixtures of this character where fine chips can get into the holes I have found it advisable to make locating holes straight rather than tapering, since when the holes are tapering there is a strong probability of fine particles getting in the holes on one side of the pin, thus causing the work to be unevenly spaced; but where the hole and pin are straight if the pin enters the hole, it must necessarily locate the spindle properly. If the holes and pins are properly ground and lapped, they will retain their size for a long time. In order to facilitate the pin entering the hole the end should be chamfered somewhat.

One thing that is sometimes overlooked is the inability of the cutter arbor to do the work without springing. Many times cutters are made with holes so small that the arbor cannot stand to the work without springing. If arbors are made for a special job and are to be subjected to great strain, they should be as short as possible. When milling the job shown in Fig. 23, it occurred to us that not only could we mill two hubs at a time, but we could also make each cutter able to mill the spaces between two teeth each time, making a cutter of the form shown in Fig. 24.

In Fig. 25 is a fixture that was used to mill a square on the end of an axle, but with the four sides slightly taper with the axis of the axle. On this account it was necessary to use an end mill rather than a face mill and in order to use an end mill in the ordinary milling machine, the fixture must hold the axle in a vertical position and with the axle standing at the right angle to produce the proper taper. It was found to be impossible to drill the spacing holes in the indexing dial of the fixture with sufficient accuracy by holding it between the

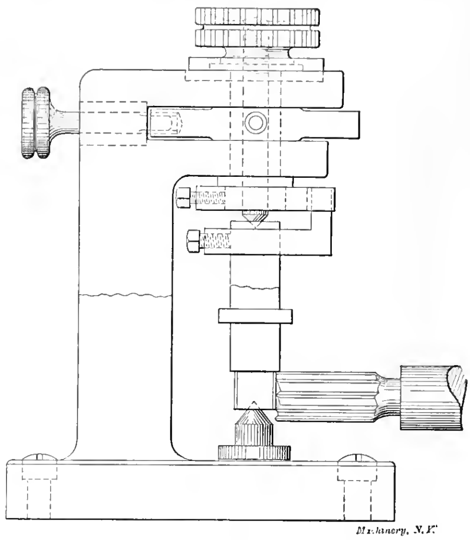

Fig. 25. Fixture for Squaring End of Axle.

centers of the dividing head when the holes were drilled on the universal milling machine, and we were obliged to resort to another scheme. A disk about six inches in diameter was placed between the centers of the universal milling machine and by means of an end mill was squared. When tested with a square, it was found that the sides were not exactly square with each other, however, and they were carefully scraped until they were as square as it seemed possible to get them. The disk was then placed on a stud located on an angle plate attached to the face plate of a lathe. The indexing dial we were to drill was then fastened to the squared disk and after locating one side of the latter parallel with the face plate, a hole was drilled and bored in the dial at the proper location, after which the stud was turned so the next side of the squared piece was parallel with the face plate. By continuing this method four holes were drilled and bored that were equidistant from each other. These holes were bushed with hardened steel bushings, ground inside and out-

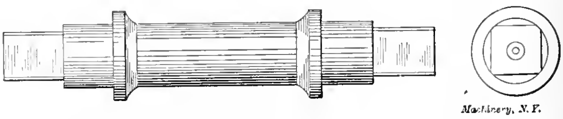

Fig. 26. Axle Milled in Fixture shown in Fig. 25.

side, and then forced into the holes. Pieces milled on this fixture and which were located by this dial were found so nearly square that no error could be detected when tested with a square. Fig. 26 represents the axle whose ends were milled.

The writer has attempted to avoid using complicated fixtures in illustrating the various methods of doing work, as they are so confusing, and the simple fixtures illustrate the methods involved as well.

There are certain principles which must be observed in designing fixtures of this character. These can be more plainly illustrated when simple fixtures are shown, but the designer may elaborate as much as is necessary to produce a tool adapted to the work in hand.

PROPORTIONS OF HAND TAPS IN SETS.

H. D.

In the October issue of MACHINERY I read an article, "The Proportions of Hand Taps" (in sets), which I thought was of great suggestive value, and I am greatly indebted to the contributor of the article in question for having so thoroughly treated this subject which I myself but lightly mentioned in my article, "Hand Taps with Standard Threads" in the July issue.

However, the contributor would have obtained a still better set of taps than the one he made if he had stopped to consider the point which he but lightly mentioned, viz., the diameter in the angle of the thread. No doubt he obtained a far better set of taps than those usually manufactured for the market, but he did not get the best set of taps obtainable. In order to accomplish this the taps should be made not only with a difference in the diameter on the top of the thread, but also with a difference in the angle diameter of the thread a considerable amount larger than what he mentions (0.001 to 0.002 inch).

Although the dimensions given in the article referred to for the different taps are well proportioned, if the taps are made without any difference in the angle diameter, it is obvious that as soon as a variation occurs in the angle of the thread the dimensions on the outside of the tap must necessarily be changed. For this reason I have laid out two diagrams showing the difference in the angle diameter for the various taps both for United States standard threads and for standard sharp V-threads, and have also shown by different shading how much each tap will be required to cut. The problem to consider is evidently a far more difficult one in this case, having two factors to contend with, viz., the difference in the outside diameter and the difference in the angle diameter. I consider the areas that each tap will remove, as stated in the article referred to, fairly well proportioned, even for taps made with a difference in the angle diameter. The only suggestion I would make is that the finishing tap be made in such a manner as to remove somewhat more than 1-16 of the total area of the thread.

According to the formulas given below, the proportion of the areas of the thread to be removed by each succeeding tap will be approximately as 6:3:1. Considering the matter in the same order as the former contributer, first considering the V-thread, and taking the pitch of the thread as the working factor, the distances from the top of the full thread to the top of the thread of the plug and taper taps respectively will be found according to the following formulas:

$$a = 0.15 \times \text{pitch}.$$
$$b = 0.47 \times \text{pitch}.$$

For the relative values of a and b see Fig. 1, showing diagram of the sharp V-thread. Again considering the difference in the

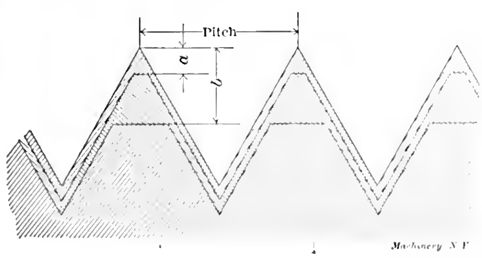

Fig. 1. Proportions of a Set of Taps for V Thread.

angle diameter of the thread, this ought to be an amount c and d respectively smaller than the correct angle diameter for the plug and taper taps.

For plug tap $c = 0.09 \times$ pitch.

For taper tap $d = 0.17 \times$ pitch.

For United States standard thread the formulas would be:

$$c = 0.05 \times \text{pitch}.$$
$$f = 0.33 \times \text{pitch}.$$

For the differences on the top of the thread (for the relative values of c and f see diagram, Fig. 2).

The angle diameter perhaps should, strictly considered, vary differently from that of a sharp V-thread, but the variation would be so slight that it can be eliminated in all practical considerations, and the variations between the correct angle diameter and that of the plug and taper tap can be made the same as for sharp V-thread, viz., 0.09 × pitch for the plug tap, and 0.17 × pitch for the taper tap.

For convenience, and in order to save the trouble of figuring the values from the formulas in each individual case, a table is given herewith, stating the amounts found from the formulas. The quantities a, b, e and f are given as $2a$, $2b$, $2e$ and $2f$, thus giving the differences for the diameter (a, b, e, and f being the difference on one side only).

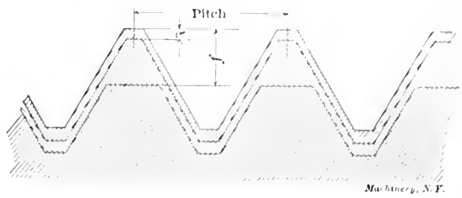

Fig. 2. Proportions of Set of Taps for U. S. S. Thread.

Only so many decimals are given as the writer considers necessary for all practical purposes. The same general arrangement of the table as used by the former contributor has been followed in order to make comparison easier. The differences in the angle diameters, although alike for United States standard thread and sharp V-thread has been repeated in both tables in order to secure uniformity.

No. of Threads per inch.	Pitch.	U. S. Standard Thread.				Standard Sharp V-thread.			
		$2f$	$2e$	d	c	$2b$	$2a$	d	c
3	.3333	.222	.033	.056	.030	.312	.100	.056	.030
3½	.2857	.190	.029	.048	.026	.269	.086	.048	.026
4	.2500	.167	.025	.042	.023	.235	.075	.042	.023
4½	.2222	.148	.022	.037	.020	.209	.067	.037	.020
5	.2000	.133	.020	.033	.018	.188	.060	.033	.018
5½	.1818	.121	.018	.030	.016	.171	.055	.030	.016
6	.1667	.111	.017	.028	.015	.157	.050	.028	.015
7	.1429	.095	.014	.024	.013	.134	.043	.024	.013
8	.1250	.083	.012	.021	.011	.118	.037	.021	.011
9	.1111	.074	.011	.018	.010	.104	.033	.018	.010
10	.1000	.067	.010	.017	.009	.094	.030	.017	.009
11	.0909	.061	.009	.015	.008	.085	.027	.015	.008
11½	.0870	.058	.009	.014	.008	.082	.026	.014	.008
12	.0833	.056	.008	.014	.008	.078	.025	.014	.008
13	.0769	.051	.008	.013	.007	.072	.023	.013	.007
14	.0714	.048	.007	.012	.006	.067	.021	.012	.006
16	.0625	.042	.006	.010	.006	.059	.019	.010	.006
18	.0556	.037	.0055	.009	.005	.052	.017	.009	.005
20	.0500	.033	.005	.008	.0045	.047	.015	.008	.0045
22	.0455	.030	.0045	.0075	.004	.043	.014	.0075	.004
24	.0417	.028	.004	.007	.004	.039	.0125	.007	.004
26	.0385	.026	.004	.0065	.0035	.036	.0115	.0065	.0035
27	.0370	.025	.0035	.006	.0035	.035	.011	.006	.0035
28	.0357	.024	.0035	.006	.003	.034	.0105	.006	.003
30	.0333	.022	.0035	.0055	.003	.031	.010	.0055	.003
32	.0312	.021	.003	.005	.003	.029	.0095	.005	.003
34	.0294	.020	.003	.005	.0025	.028	.009	.005	.0025
36	.0278	.019	.003	.0045	.0025	.026	.0085	.0045	.0025
38	.0263	.018	.0025	.0045	.0025	.025	.008	.0045	.0025
40	0250	.017	.0025	.004	.0025	.0235	.0075	.004	.0025
42	.0238	.016	.0025	.004	.002	.0225	.007	.004	.002
44	.0227	.015	.0025	.004	.002	.0215	.0065	.004	.002
46	.0217	.0145	.002	.0035	.002	.0205	.0065	.0035	.002
48	.0208	.014	.002	.0035	.002	.0195	.006	.0035	.002
50	.0200	.0135	.002	.0035	.002	.019	.006	.0035	.002
52	.0192	.013	.002	.003	.0015	.018	.006	.003	.0015
54	.0185	.0125	002	.003	.0015	.0175	.0055	.003	.0015
56	.0179	.012	.002	.003	.0015	.017	.0055	.003	.0015
58	.0172	.0115	.0015	.003	.0015	.016	005	.003	.0015
60	.0167	.011	.0015	.003	.0015	.0155	005	.003	.0015

The former contributor infers that taps of this description are not manufactured for the market at all. It is true that they are not generally manufactured in this manner, but the writer made a special study of this and kindred subjects at the St. Louis exposition last year, and although he found only one firm manufacturing taps in this way, it must be added to the credit of the manufacturers that at least one leading firm (Pratt & Whitney Co.) has not overlooked this important matter.

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MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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DECEMBER, 1905.

PAID CIRCULATION FOR NOVEMBER, 1905,—22,317 COPIES.
Including 705 advertisers' copies, as part of their contracts.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

It is not according to custom for the publishers of a mechanical journal to issue a holiday edition for the month of December, as in the case of the general magazines. On the face of it there do not appear to be very close ties between the daily routine work of the mechanic, with which a journal like MACHINERY has to deal, and the spirit of freedom and gaity that pervades the Christmas atmosphere. Yet, to how great an extent has mechanical science contributed to the season's enjoyment! How many gifts are made nowadays that the mechanic has not a hand in producing? How about the mechanical toy? The Christmas tree, lighted by incandescent lamps, is far safer than when illuminated by the incendiary candle; and it would seem that "Old Nick," arriving at the chimney top in an automobile, should render more efficient service than in days when he traveled in the historic sleigh. While MACHINERY shows no outward manifestation of the approaching holidays, it extends greetings to its many friends and believes that the mechanical work in which its readers are engaged contributes not a little to the pleasure of the Christmas season.

* * *

THE WORLD'S MARKETS.

Do American machinery manufacturers, as a body, realize how important foreign trade is to them? Of course those whose sales will be cut off by the impending increase in the German tariff fully realize its importance; but even those who cannot sell their product abroad are financially interested in creating and maintaining a market for other manufacturers who can, because whatever helps one helps all. A few years ago many American works were running to a great extent—as great as 75 per cent in some cases—on foreign orders; and the loss of that trade would have meant the closing of those shops. Such conditions may arise again, for this country cannot alone absorb all its manufactured product. The high protection duties which have benefited us in the past are no longer needful and should be modified; and reciprocal trade relations should be established with the great Continental nations that will keep their markets open to our manufacturers.

In a recent interview a leading German banker, speaking of the chances for a commercial treaty with his country, said: It is my opinion that slight concessions by the United States, say, in the import tariff on certain classes of articles imported from no country except Germany, and to no great extent even from that quarter, would satisfy the apparently unalterable position of Germany that a commercial treaty with your country must include some concession on your part. Granting that some such solution as I have suggested is found for this particular question, I think that all other questions involved could be settled to the mutual satisfaction of both countries.

It is to the interest of every manufacturer of machinery in the United States that the needful concessions be made.

* * *

INDUSTRIAL BETTERMENT.

One of the most interesting attempts at industrial betterment with which we are familiar is that of the Weston Electrical Instrument Co., Newark, N. J. They have not only made their factory a model of attractiveness and convenience for their employees, but have also established and turned over to their employees a club plant, a description of which appears in this number. They have attempted to eliminate entirely the element of paternalism which is objected to so strenuously by American workmen, by placing the administrative conduct of the club in the hands of their employees.

The establishment of harmonious relations between employer and employed and the elimination of discontent among the latter, through co-operation, is to be commended. There is, however, a diversity of opinion as to the best means of bringing this about and one prominent machine tool firm have expressed themselves in the following terse manner as opposed to many of the features that some other firms have found desirable:

We do not believe that it helps the man to give him something for nothing and we do not believe that he wants it. We have seen in a great many instances throughout the country where various plans of this kind have been tried, that the men rather resent it and come to look upon it as a charity which is not desired. We believe in giving a man a chance to earn his recreations, rather than provide them for him gratis, and we feel that all plans worked out on a basis of giving the man something for nothing are bound to fail, for the very reason that it can be nothing other than more or less of a charitable distribution and that the American workman is above anything of this nature.

It must be admitted that there is much to be said for this view of the situation. While we believe that every attempt to introduce social features in connection with factory life is made with an honest desire for co-operation, this action is often misunderstood and if such betterment features as are introduced were placed absolutely on a dollar-and-cent basis, some of the failures now met with in these efforts could be avoided. A manufacturer is entirely justified in introducing features that make the human part of the machinery of his plant more efficient; and while he may not at heart put it on that basis, it would perhaps be better to do so. More than this, from the fact that the manufacturer occupies a semi-public position, he is undoubtedly under *moral* obligations, at least, to make his plant, where his employees spend so many hours of their time, a healthful and comfortable place. This amply justifies the many improvements in the way of sanitation, safety appliances, ventilation, lunch rooms, etc., now provided by modern concerns. Beyond this, anything that can be introduced to improve the efficiency of his employees is justified. Whether, still beyond this, the social features, such as the Weston Company and others are introducing will accomplish their purpose can only be told in years to come.

* * *

MACHINERY has always made a feature of machine shop descriptions, and accounts of many of the best shops and shop buildings in the country have appeared in its columns. It is proposed now to extend the idea somewhat and give descriptions of several model shops of medium or small size, covering several types of construction. The first of these appears in this number in both the engineering and shop editions, and gives details and specifications of the mill-type building of the Hoefer Manufacturing Co., Freeport, Ill. In one or two other instances, also, specifications will be published and it is believed that the series of articles will be of much value to those investigating shop architecture.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A new process of preserving wood is reported by Consul Atwell, of Roubaix, France, being treatment with sugar. It is said that specimens of soft wood treated by the Powell sugar process successfully withstand the ravages of white ants in tropical countries. It is thought that the new process will make a great change in the export timber trade to tropical countries as soft wood treated by it will replace the expensive teak and eucalyptus that are now necessarily used where white ants are a pest.

A recent report by Consul Mahin, of Nottingham, England, says that the German and English machine screw manufacturers have formed a screw trust and suggests that there are possibilities for profitable American competition. Heretofore a severe competition had prevailed between British and German manufacturers but when the syndicate was organized, prices were advanced 50 per cent and the market restricted. The British market will be closed to the importation of German screws and no British orders will be received by the German manufacturers after October.

It is commonly regarded as a desirable distinction to be the first man to cross a new bridge, to buy the first ticket sold on a new railroad, etc., but all "firsts" are not so desirable. The editor of the *Canadian Engineer* has been delving in railroad history to some extent and has dragged forth the fact that William Haskinson, a minister of the British Cabinet, has the melancholy distinction of being the first man killed by a locomotive. He was killed by Stevenson's "Rocket" at the opening of the Liverpool & Manchester Railroad shortly after the Rainhill trials, which took place in 1829.

A correspondent of the *Valve World* describes a simple method for testing the flow of an artesian well under conditions where a weir could not be built. About forty feet of ten-inch pipe was screwed into a 90-degree elbow, connected to the top of the pipe where it came out of the ground, and near this connection was tapped a small hole for a pipe to which was attached a hand force-pump. The force-pump was used to draw red aniline liquid from a pail and force it into the pipe. At a given signal a quantity of the aniline fluid was forced into the pipe and of course, it was carried along with the flow of water, and at the same rate. The interval of time for the colored water to appear at the far end of the pipe was measured by a stop watch. Then, knowing the capacity of the pipe and time required for the flow to travel 40 feet, it was an easy matter to figure the amount of water passing per minute.

Coal stored in great heaps deteriorates in quality as time goes on; this deterioration is slow oxidation, and oxidation, slow or fast, is always accompanied by the generation of heat. There is no known way of preventing this action, but there is a way of avoiding serious results, and that is to provide means for rapidly carrying off the heat, and that is best accomplished by the free circulation of air through and around the pile. There is one peculiarity about stored coal for railroad use, when it does get on fire, that is not very generally known, says *The Engineer* (Chicago). The peculiarity about the fire in the interior of a pile of coal is that it cokes a layer of coal all around the fire, and this coked layer will not readily let water through, so that drenching the pile from the outside and expecting the water to soak in and put out the fire is an expectatien which is not likely to be realized. The way to put out a fire in the center of a coal pile is to push a sharp pointed piece of perforated pipe into the burning mass, couple the piece of pipe to the shop hose and turn on the water.

Consul Fleming, of Edinburgh, Scotland, calls attention to a large paper-making machine which he says an Edinburgh firm of manufacturers has just completed. It is the largest paper-making machine ever constructed in the United Kingdom. Some idea of its dimensions may be afforded by the statement that a shed 185 feet long is not sufficient to house it. The striking feature of the machine is its great width. This is called for by the fact that the paper-mill company in Sweden, to whose order it has been built, intend to use it for the making of two sheets of newspaper, each 75 inches wide—or 150 inches of finished paper. To run a sheet of this width at the high speed of 500 feet per minute requires a machine with exceptional driving gear and rolls of extraordinary diameter and weight. The paper made is to have a better finish than is customary on newspapers in Great Britain, and to that end an enormous stack of calender rolls is provided. These rolls weigh about 70 tons—the bottom one alone weighing 14½ tons. The steam engine by which the machine is driven is capable of developing 200 horse power. With all accessories the complete machine weighs 550 tons, and a special steamer has been chartered to carry it from Leith to Sweden. It is said that the price to be paid by the Swedish company is $72,997.

A weak feature of electrical apparatus, particularly dynamos and motors, is the insulation which, being usually of a vegetable nature, is easily charred by heat and requires considerable thickness in order to have the requisite dielectric strength. The *Western Electrician* refers to a new insulation which has been used with some success in Germany that promises a considerable improvement in the matter of thickness and therefore the size of coils. The new insulation when used for very fine wires is made of asetic cellulose applied by special apparatus. This covering is tough and elastic and is unaffected by humidity or a temperature of 300 degrees F. With a thickness of only slightly more than 0.001 inch it suffices for a tension of 1,500 volts. For larger wires up to 0.08 inch diameter another substance of similar qualities but resembling enamel in appearance is employed. This insulation is also very elastic and flexible and its dielectric strength permits it to withstand from 2,000 to 2,500 volts with a thickness of only 0.0006 to 0.001 inch, being thinner even than the first-named insulation. It resists temperature up to 392 degrees and is unaffected by humidity. If these insulations are as efficient as reported it would seem that they leave little to be desired. With their extreme thinness and exceptional dielectric strength it will be possible to make high tension coils very compact.

A correspondent of *Mechanical World*, Mr. R. Berry, Birmingham, Eng., gives it as *his* theory that the width and thickness of a driving belt should be decided only by the factor of safety employed, which in a measure also decides the life of the belt. In explanation he says that if we take two belts, say one is 3 inches and the other 6 inches wide, both single leather and made of the same class of material in every respect, with the working conditions, as regards velocity and total tension between the two shafts the same, then the 3-inch belt will do a given amount of work equally as well as the wider belt, so far as gripping the pulley is concerned. But owing to the tension per inch of width in the case of the narrow belt being twice as great as in the wider belt, its life will obviously be only one-half that of the 6-inch belt. The power to grip the pulley and to transmit energy will be the same in each case, which brings us to the fact that the output of any belt in foot-pounds depends solely upon the velocity measured in feet per minute times the total tension between the two shafts, measured in pounds, and also on the coefficient of friction. No other factors need be considered within ordinary working limits. He refers to the advice often given by writers that the tension of a belt should never be increased where greater power is required, but to either make the belt wider or to make it double thickness, their argument being that unless this is done the shafting and bearings suffer. The fallacy of this is pointed out inasmuch as the total tension must be the same in either case, the coefficient of friction

being the same; hence the effect on the shafting is the same whether the tension is increased on the original belt or a wider or thicker belt is employed. He advises that single belts should not be run at a tension greater than 300 pounds per square inch of cross-sectional area, but is inclined to favor high belt speeds, up to 4,500 feet which he regards as being about the maximum speed that should be employed, for beyond this speed he asserts that no real economy exists.

One of the most desired inventions in mechanics or thermodynamics is the utilization of gas or oil for the driving of a turbine. There have been many attempts to solve the problems, one of the principal of which is the compression to a sufficiently high pressure of the air required for combustion, and, although the success of the past has been largely negative, the process of trial and error makes progress. A French engineer, M A. Barbezat, has constructed an experimental turbine which is worth notice, although it is on perhaps too small a scale to prove commercial potentialities. His machine is a continuous combustion turbine. The combustion chamber is lined with refractory material. The petrol is fed through a nozzle having an outer ring, forming a passage surrounding the petrol nozzle for the supply of high-pressure air, from a compressor on the turbine shaft. The air and petrol are ignited electrically and attain a temperature of 1,800 degrees C. (3,200 degrees F.). The gas given off by combustion passes out of the chamber through nozzles, impinging against and driving the blades of the turbine. To keep the blades cool low-pressure steam is also admitted into the turbine casing, this steam being generated in water jackets around the gas nozzle. This turbine is said to give a thermal efficiency of 18 per cent, and that improvements now being made will increase this to 26 per cent. The question seems still to be the efficiency of the compressor.—*Practical Engineer.*

The camera is a very useful instrument in the shop for the purpose of record and illustration, but it has another useful field that is used to a very limited extent, and that is microphotography. It is the impression of most people that microphotography requires the use of highly expensive apparatus and an operator skilled in this particular branch. A writer in the *Scientific American* of November 11 describes a simple apparatus for making microphotographs which requires nothing more than an ordinary camera with focusing glass and a cheap microscope costing $1 or less. The microscope is seated in a wooden block which is set on the camera bed in front of the lens so that the axis of the microscope is in line with the axis of the camera lens. The subject to be microphotographed is mounted on the microscope objective, which, of course, is faced toward the light. The distance between the lens of the camera and the microscope depends upon the circumstances and will have to be found by trial, the distance varying from, say, one inch to immediate contact between the microscope and the lens. The lens should be wide open and no stops should be used. Time exposures, of course, are necessary, from thirty to forty-five seconds being usually sufficient on a bright day, using a fast plate. The time required depends also upon the degree of magnification, the greater the magnification the longer the time. The apparatus must be rigidly supported to prevent vibration, as otherwise there will be a noticeable lack of sharpness in the negative.

GALALITH, A NEW INDUSTRIAL PRODUCT.

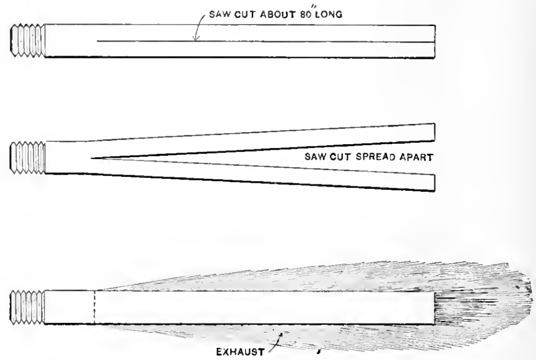
In the June, 1904, issue a short note was published on a new industrial product called "galalith," which is made from the curd of cow's milk. In a recent report Consul-General Guenther gives some additional information on this new useful substance:

"Galalith is a new horn-like product from cow's milk. From the milk of certain species of plants very valuable products have for a long time been made for the manufacture of plastic goods, as, for instance, hard rubber, known to everybody. That animal milk, especially cow's milk, also contains a similar exceedingly valuable ingredient is shown by the new horn-like substance galalith. Incredible as it may sound, galalith is in fact made entirely from cow's skimmed milk, without addition of foreign substances, only by employing a certain process of hardening. The process of manufacture is protected by patents in all civilized countries.

"Galalith is produced in all colors, various marmorean designs, and imitations; the imitations of turtle-shell, amber, corals, etc., are as similar to the natural product as one egg is to another, so that galalith turtle-shell, for instance, is hardly to be distinguished, even chemically, from genuine turtle-shell. The colors are the finest and most brilliant. Compared with celluloid, galalith possesses the essential advantage that it is absolutely odorless and not at all inflammable. In consequence of its properties, galalith is to be classed with the most precious natural products, but can be procured at much lower cost. It is already used for the manufacture of combs, clasps, hairpins, cigar and cigarette holders, handles for pocketknives and razors, handles for umbrellas and canes, backs of brushes, snuff boxes, rings, inlaid ornaments for fine furniture, balls and pearls, buttons, penholders, pencils, paper-knives, seals, crochet needles, chess figures, dominoes, dice, etc."

SIMPLE GAS ENGINE EXHAUST MUFFLER.

A simple device for making exhaust of gas engines noiseless is briefly described in an English publication, but in a manner which leaves some doubt as to the exact construction. It is, however, worth noting, and we have drawn the accompanying sketch which appears to us to be the idea described. The exhaust pipe is split for about 80 inches from the top, and the split ends are opened by bending the halves of the



Gas Engine Exhaust Muffler.

pipe apart until the top of the slot has a width equal to the diameter of the pipe. The puff of the exhaust then spreads out like a fan and the discharge into the open air takes place more gradually than it would from the ordinary opening. This practice is said to be effective in reducing the sharp explosive sound of the exhaust, but the best results depend somewhat upon the flare of the tube. Of course the length also is a factor and would be necessarily greater with a large engine than a small one.

WATER POWER IN THE ALPS.

Consular Report.

In upper Italy, Switzerland, and France great progress has been made within the last few years in utilizing water power for electric currents, while in this respect Germany has somewhat lagged behind. The cause is, however, easily found. Germany is blessed less with natural water power than the countries named. It must be borne in mind that the number of waterfalls and their quantity of water is of less importance than the height of the falls. A fair illustration is found in Sweden, which, however, has also made great efforts to utilize its water power. In Germany the Danube and the Rhine, with their tributaries, are principally to be taken into account.

An exhaustive article in the *Electrotechnical Advertiser* deals with the problem regarding progress made in Germany, and especially in Bavaria, in the utilization of natural water power. Since 1899 there has been in Bavaria a State Hydrotechnical Bureau, which has made systematic and thorough measurements of all the river districts. Certain results are, however,

restricted only to about one-third of the Kingdom, but they include the rivers coming from the northern slope of the Alps. With reference to the Danube it has been determined that, as far as its course in Bavaria is concerned, its water power, inclusive of all Alpine tributaries, is about 1.9 million horse power. Of this only 37 per cent., or 700,000 horse power, could be converted into useful power. It is estimated that the water power of the entire northern slope of the Alps is about six million horse power.

Of the 700,000 horse power available in upper Bavaria, so far only 75,000 has been utilized, or a little over 10 per cent, while in Switzerland and in the Austrian Alps 350,000 horse power, or 15 per cent, has been obtained from the natural water power. Further development depends upon whether the electric power so obtained from the water forces can be employed profitably. Mountain railroads, which are especially adapted for the employment of "white coal," can only be made profitable where the scenery is very attractive. The electrochemical and the electro-metallurgical industries are most interested in such power plants. The factories on the river Lech at the Rhine falls, etc., are illustrations.

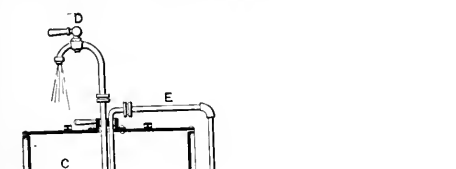
The rivers of the Bavarian Alps possess a considerable disadvantage compared with those of Switzerland and upper Austria on account of the lesser height of their falls. The turbine industry has therefore been obliged to resort to peculiar methods in order to utilize in a satisfactory manner the waters of rivers where the fall is limited.

SAFE STORAGE OF EXPLOSIVE LIQUIDS.

At a meeting of the Hanover Branch of the German Engineers' Society Prof. Schleyer described a system of fireproof storage of volatile explosive liquids, such as benzine. The dangers that exist without special precautions are (1) that high external temperature may cause bursting of the containing reservoir; (2) that the vapor of the liquid may form an explosive mixture with the air; and (3) that the liquid, in case of leakage in or damage to their containing vessels, may become ignited.

The first damage can be avoided by safety-valves.

That of the formation of explosive compounds ignitable at a low temperature is, however, always present, when ordinary



Arrangement of Storage Tank for Explosive Liquids.

air takes the place, in the reservoir, of that portion of the liquid which is drawn off. The attempts which have been made to protect the contents of the receptacle by means of fine wire gauze on the principle of the Davy safety lamp have proved futile, as the gauze is so easily injured, and if red hot affords no protection.

Absolute safety from explosion can be attained only by preventing the formation of explosible vapor mixtures. One way of accomplishing this is to replace the dangerous liquid which is drawn off, by an equal volume of a non-oxidizable liquid—as for instance water—or of an "indifferent" gas such as carbonic acid gas. Experiments have shown that the admixture of only one-fifth part of carbonic acid gas effectually prevents explosion.

The danger can be further lessened by such an arrangement as will insure that if a fire occurs near the reservoir of dangerous liquid the latter will be automatically transferred, by the resulting vapor pressure, to another reservoir, which shall be in a fire-proof situation.

One such arrangement is shown in the illustration. *A* is a cylinder of compressed carbonic acid gas; *B* a fire-proof subterranean reservoir; *C* the ordinary reservoir which may become exposed to fire; *D* the tap. As soon as *D* is opened, the compressed gas drives the liquid out of *C* and takes its place, thereby precluding the possibility of explosion at that place. Should by reason of a fire the gas pressure in *C* rise, the liquid will flow by the pipe *E* to *B* and there be in safety; that is, will leave the place of danger, automatically. The carbonic acid in *B* will escape through the U-tube, which is filled with mercury, and which also serves as control for the reducing-valve. If the reservoir should be injured by the fire, the carbonic acid will escape and act as an extinguisher. Water may be used instead of carbonic acid gas. R. G.

THE CHICAGO FREIGHT TUNNELS.

Times Engineering Supplement, September 20, 1905.

During the past four years Chicago has been occupied in providing itself with a system of shallow tunnels, on lines which differ broadly from underground means of transport followed in other cities. The most congested quarter of the city is being duplicated some 33 feet below the road level by the construction of underground passages following the plan of the streets, constituting what may suggest lower stories of the thoroughfares above. Their special feature is that they are only to be utilized for the conveyance of goods. Up to July 31 last, practically 33 miles of these tunnels were completed, and the work is now being pushed forward at the rate of about 500 feet a day. The mileage completed does not mark a limit to this curious network of freight tunnels, and they will probably reach more than double the length in course of time. But what already has been done has not been altogether plain sailing. Subsidences and street depressions have lately occurred, into which a committee has been inquiring, and they find them to be attributable to the neglect of employing air-pressure (which they order shall be used in all future work) in cutting the connections and by-passes branching from the main-line tunnels. For the latter the pneumatic system was used, and no subsidence is to be traced to them. The Chicago city authorities, apparently, have generally allowed the constructing company a free hand in their operations, to judge from the comments of the committee, who have availed themselves of the occasion to investigate the checkered history of the whole work. The result is a critical report in which they regret that a scheme of such magnitude was not based upon a coherent and comprehensive plan, and they point to the report of the Royal Commission on London Traffic as indicating the inquiry which should have been made before the tunnels were begun.

Chicago claims to have discovered a golden rule for modern urban transit, namely, "streets for the people, tunnels for goods." On the face of it, underground roads of this kind seem more suitable for goods than for human transport. No passengers, in fact, are to be carried in the Chicago tunnels. How far the freight tunnels of Chicago will effect a clearance of the vehicles which overload her business quarter remains to be seen; but the project at any rate appeals to common sense, and the wisdom of the experiment cannot be questioned. It may be remarked, however, that the compact area of the city's industrial center lends itself to the establishment of a network of freight tunnels beneath it. Were the business quarter spread over a wider area, somewhat segregated in parts, and generally less concentrated, as is the case with many other cities, a system of freight tunnels would not perhaps be so practicable. This "down-town" district, it may be mentoned, although only $1\frac{1}{2}$ square miles in area, is regarded as the most congested in the world. Therein is stated to be centered 35 per cent of the railway mileage of the United States, 14 per cent of the entire world's mileage, the termini

of 25 trunk lines, and in and out of it are shipped 40,300,000 tons of goods in one year. These figures may slightly err on the side of exaggeration and admit of some correction; but there is no doubt that the traffic is far too great for the small area containing it.

Originally, the purpose of the promoters was the more modest one of running conduits a little below the street surface to carry telephone cables; but the idea of tunnels was eventually adopted, and the scheme finally matured in the linking of an automatic telephone system with freight transport, such as the carrying of mails, newspapers, parcels, and general goods, through the tunnels. Building operations have proceeded without even owners of property being aware of the extensive excavations going on, as the removal of soil by cars was effected at night, through shafts sunk from the street levels, and from an opening in the river bank, whence it was shot into barges. Unlike tube lines designed for passenger traffic, the tunnels do not even reveal their existence by emerging into stations at the street level. There are, in fact, no stations; as what may pass for such are merely elevators connecting with the cellars of large establishments by means of spur tracks along the line. Down these elevators the goods will be sent, for despatch through the tunnels to the railway termini, where there are also connecting elevators, as well as at the main and branch post offices and goods depots. The plans of new buildings now in course of construction even go further by fixing the foundations on the same level as the tunnels, so as to admit of the basement answering the purpose of a freight railway station under the ground. When in Chicago the writer was shown several of these "basement stations," for that is what they practically are. Every building in the business district of Chicago can be equipped with tunnel connections, which would place it in direct communication with the trunk lines, and there is apparently no limit to the extent to which "stub" tracks can be branched off at any point along the line for this purpose. The tunnels also admit of special facilities for the transit of coal, and for the quick disposal underground of ashes and débris from the streets.

The thirty-three miles of tunnels so far complete, with the necessary by-passes and intersections, 300 in number, are at present only being used for the purpose of removing soil to the lake shore. They are of horse-shoe section, the walls and floors being lined with concrete. Gridironing the "down-town" district, the roofs restricted to a distance of not less than 24 feet 6 inches from the street surface, they practically run beneath every block, with cross-over curves at each intersection. For about a mile there is a trunk tunnel, 14 feet 6 inches high, and 12 feet 9 inches wide (inside measurement), with 21-inch floors and 18-inch concrete walls; the rest are lateral tunnels 7 feet 6 inches high, by 6 feet wide, with 13-inch floors and 10-inch walls. The excavation operations for these main tunnels, which generally yielded a blue clay, were effected under pneumatic pressure, and spades and hooped-shaped drag-knives were used in cutting through. As each 20-foot section was excavated, 5-inch steel channels, in two pieces, bent to the exact shape of the tunnel curves, were set up, 3 feet apart, with lagging planks or frames placed outside of them, and the space between the lagging and the surface of the clay was filled in with concrete properly packed to bond it with the last completed section. The floor was first laid, then the walls on each side, and the key space at the top was next filled up and thoroughly rammed to prevent any movement of the body of the clay, which would disturb the stability of the important buildings above. All the 35,000 cubic yards of concrete used were manufactured in basements near the shafts, the material (cement, sand, and gravel), being passed down an inclined chute from the street on to a conveyor belt driven by electricity, which delivered it into storage bins. At the intersections, where the concrete has a less proportion of sand or gravel than at other parts, and is therefore richer, the corners are rounded off, and the roof is supported by transverse rolled steel joists or roof beams, with concrete arches between them. The view of the completed tunnels from the intersections suggests ancient catacombs.

The cables of the automatic telephone system now in operation, which are already serving between 4,000 and 5,000 stations, are strung along the roof and walls in lead sheaths, and pass up lateral drifts, 3 feet in diameter, which connect with the street level, then along manholes near the surface, and through the ordinary conduits to the various buildings.

The permanent way is of 2 feet gage, laid with 56-pounds flangerails, over which 5-ton electric automobiles are being run experimentally, taking their power from an overhead trolley wire; but some parts of the system are equipped with a third rail conductor. The tunnels have bright incandescent lights, and a slow service is contemplated in which no signals are to be used, and all the switches at the cross-over points will be worked by hand. The operation of the traffic, in short, will be more applicable to slow movement of street cars in crowded parts of a city than to steam railways. The president, Mr. Albert G. Wheeler, estimates that 30,000 tons of freight will be handled daily when the tunnels are in operation.

STEPS AND PRESS EMPLOYED IN MAKING RAPID-FIRE CARTRIDGE SHELLS.

The successive steps employed in heading cartridge cases or shells were illustrated in a recent issue of *Engineering* in connection with a description of a cartridge case heading and indenting press, built by the Vauxhall & West Hydraulic Engineering Co., London. The press was designed for performing the heading operations upon ammunition shells used in rapid-fire guns. After a shell or case has been drawn to the required internal and external diameters and the mouth trimmed, it is necessary to redistribute the metal in the solid end of the case so as to form the seat for the primer and projecting flange of the head. This requires three operations, known as "first" and "second indents" and "heading." The drawn shell is shown at A, Fig. 1, and at B it has received the first indent which raises a boss on the interior of the shell for the primer and initiates the operation which finally results in forming the flange. At C the primer hole is shown perforated and at D the surplus metal is shown headed over to form the flange.

The hydraulic press required for these operations is necessarily heavy (116,500 pounds), and capable of exerting great pressure. The top entablature of the press, Figs. 2 and 3, forms also the main cylinder A, in which works an inverted ram fixed to a guide cross-head, B, with adjustable slippers,

Fig. 1. Order of Operations in Making Rapid-fire Cartridge Shells.

these working on the columns of the press which connect the upper entablature to the case. To the ends of this cross-head are fixed the ends of two rams, C, for returning the main ram into its cylinder after each stroke. The cylinders in which these side rams work are connected direct to the hydraulic-pressure mains, so that the side rams exert a constant upward pressure below the cross-head, and thus raise the latter whenever the valve of the main cylinder is open to exhaust. The base of the press is a cored casting, from the under-side of which is suspended a powerful ejector ram, D, for forcing a headed cartridge-case from the die; on the upper face of the base is arranged a circular block of gun steel, which can be rotated through 180 degrees by the wire rope and two jigger cylinders, E, seen in the illustration. The die-block, which is fitted with two dies, is carried by a vertical shaft, and is also recessed into the top of the press base. The two dies are diametrically opposite each other, and are so arranged that when one die is exactly under the center of the main ram the other die is over the ejecting-ram.

In describing the working cycle it is assumed that the main ram is at the top of its stroke, the ejecting ram at the bottom

of its stroke, and the rotatable die-block is in one or other of its working positions. A partly finished case, of the shape shown at *A*, in Fig. 1, is placed in the die-block over a mandrel which rests over the ejecting-ram; by means of the hydraulic jigger cylinders the die-block is rotated through an angle of 180 degrees, and the cycle of operations now commences: The case being under the center of the main ram, the follower of which is fitted with a revolving die-plate holding three dies—*i. e.*, two indenting and one heading dies—the dies are turned until the first indenting die is over the cartridge-case, when pressure is admitted to the main cylinder, and the ram forces the die into the solid metal of the case, and makes a shallow depression in the center of the latter, as shown by *B*, Fig. 1. The main ram now ascends, and the second indenting-die is brought into position and the stroke repeated, which leaves the case with the central depression so enlarged that the end of the case has the appearance of a flat circular plate surrounded by a low wall, as shown by *C*. The ram is then again raised, and the die-plate swung round until the heading-die is under the ram, which then descends and flattens down the wall left by the last operation, and thus forms the rim of the cartridge-case as shown by *D*.

During these three successive working strokes of the main ram the lower die-block has remained stationary, and may be assumed to contain in the die-block over the extractor-ram a finished case. This case is next ejected, and a new case placed in the die, so that, when the three strokes of the main ram are completed, the die-block may be rotated, and the cycle of operations repeated. The method of rotating the die-block is simple, and is decidedly preferable to the more common means of a rack and pinion; as the rope is always subjected to the tension of the smaller jigger ram, which is of course constantly under pressure, so that it is impossible for there to be any play or lost motion. The exact reversal of the die-block is limited to 180 degrees by the nuts and lock-nuts on the guide-bars of the crosshead connected to the larger jigger ram; and any stretch in the rope is automatically taken up. In addition to this, the length can be adjusted by the screwed eyes at each end of the rope.

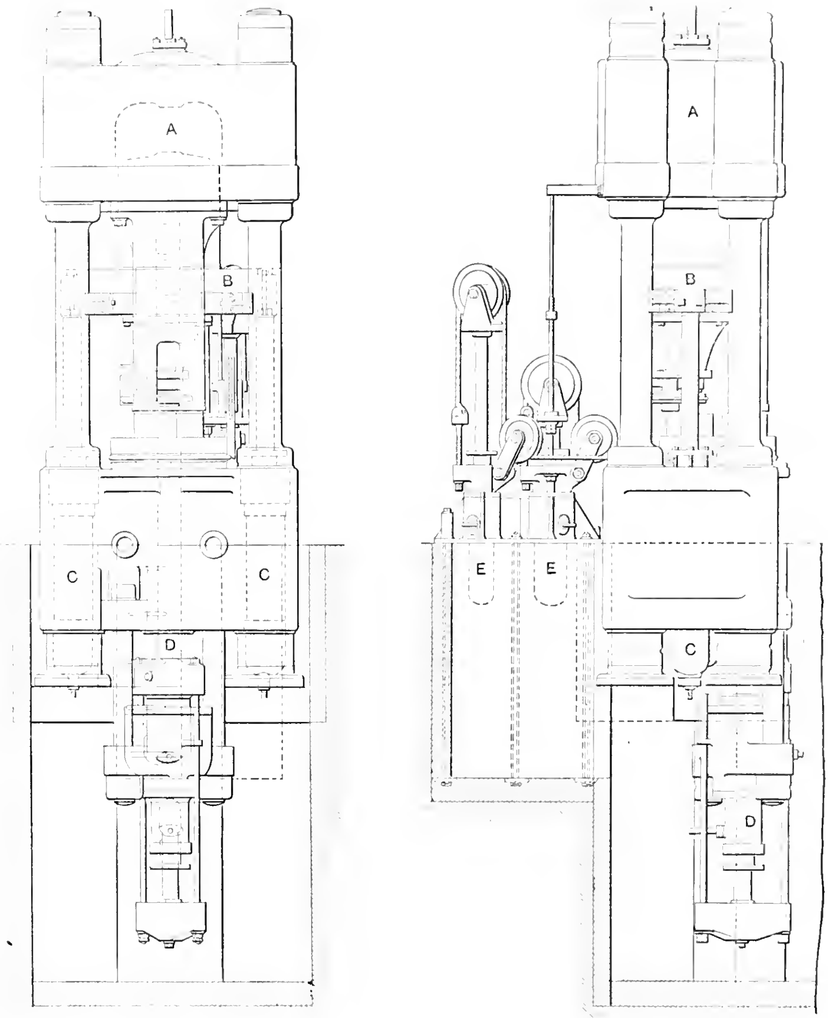


Fig. 2. Fig. 3.

Front and Side Views of Cartridge-case Heading and Indenting Press

THE SMOKE QUESTION.

W. H. Booth, in Times Engineering Supplement, Nov. 5, 1905.

The public generally, and, it is to be feared, many engineers also, regard smoke production as inevitable. Patentees and makers of such apparatus as mechanical stokers, devices for admitting air and for increasing draft, of hollow bars, and a hundred other things, all labor under the disadvantage that they do not appreciate the scientific aspects of the combustion of fuel, and none of the many appliances sold for the prevention of smoke make any thorough attempt to combine the few essentials of perfect combustion. These few essentials are the provision of an adequate quantity of air to combine with the fuel; the sufficient mixture of such air with the gases from the fuel; the provision of a suitable space in which these gases can complete their union with the oxygen of the air; and last, but equally important, the conservation of a temperature sufficient for such union. It is this last essential that is usually—indeed almost always—absent from all devices. Thus in the internally fired boiler of the Lancashire and similar types, the furnace is bounded by water-cooled plates, while the whole of the combustion chamber is water-cooled, and is frequently also provided with still further refrigerating agencies in the shape of water pipes placed diagonally across the tube. In most water-tube boilers the gases from the furnace rise vertically from the fire and pass directly into a closely set bundle of cold-water tubes. The mixture of gas and air which is fairly accomplished by the longitudinal sweep over the fire in the Lancashire boiler is absent in the common furnace arrangement of most water-tube boilers. Thus, while the Lancashire boiler possesses a furnace correct in form, it lacks temperature. The water-tube common furnace lacks both the form to produce mixture and the temperature. The result is that while a so-called smokeless Welsh coal can be burned smokelessly in the Lancashire boiler it will produce smoke in the water-tube boiler.

These facts lead up to a consideration of coal as a smoke producer. True anthracite will produce no smoke in any furnace. In a badly designed furnace it may burn imperfectly to carbonic oxide with great loss of effect; but there will be no

colored smoke. Bituminous coal alone will produce smoke, and bituminous coal varies very greatly in quality. It ranges from the best class of smokeless Welsh, which contains little volatile hydrocarbon, up to the fully bituminous qualities which may contain 30 per cent or more of hydrocarbon.

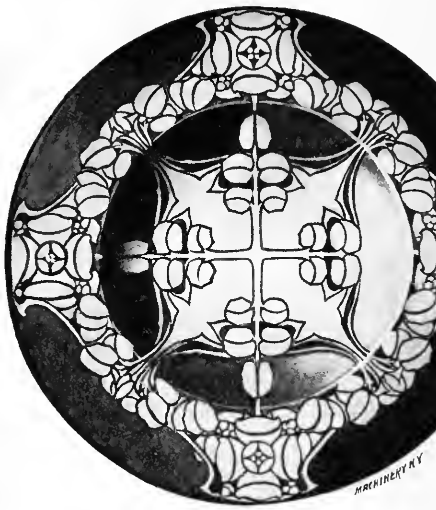
When a bituminous coal is employed, that part which is solid carbon is burned on the grate. The volatile portion is distilled into gas, and burns beyond the grate when mixed with air and kept sufficiently hot to burn. Obviously a coal consisting mainly of carbon, which will burn on the grate, will produce a vast amount of heat at the grate surface, and the volatile portions when driven off are raised to a sufficient temperature to burn promptly before they have traveled far and become cooled by contact with the cold boiler surfaces. But with a highly bituminous coal there is very much less carbon to burn at the grate surface, and so much less heat is therefore evolved. Much of this heat is promptly absorbed in effecting the distillation of the volatile parts of the coal, which renders latent a large amount of heat in the process of vaporization. Thus with less heat generated, and more hydrocarbon to distill, there is not much energy left over to heat up the volatile matters to ignition temperature. On the contrary, their volume is great, and the surrounding boiler plates so greedily absorb heat from them, that at the time of firing there is too low a temperature to permit of perfect combustion. The half-consumed gases, when thrown against cool boiler surfaces, split up, therefore, in a curious manner and throw out carbon as soot. They do this even when fully mixed with air if the temperature is too low for complete combustion.

According to the percentage of hydrocarbon, therefore, will be the intensity of the smoke. Mechanical stokers, by continuously supplying fuel to the furnace, reduce the volume of the smoke, but they are by no means able to cure the evil. Often they are merely equalizers of the rates of smoke production. Given, therefore, proper air admixture with the gases, and space in which combustion can be completed, there remains only the conservation of temperature as the final essential to smokelessness. This can only be secured by surrounding the path of the burning gases with a non-absorbent substance such as firebrick. Now there is nothing to prevent the employment of firebrick for the lining of a circular flue tube of a Lancashire boiler. This is done when the fuel is dust coal blown into the furnace by a blast of air, and the burning of this fuel is carried out without smoke. It is done also where liquid fuel is burned, because liquid fuel, being composed wholly of hydrocarbons, and having nothing solid, smokes so foully that proper furnaces are rendered absolutely necessary. It should, therefore, be equally possible to line any internal furnace for the purpose of maintaining the heat of the gases until they are so far burned that they may pass on to a colder unlined portion. The peculiarity of the hydrocarbon gases is that the hotter they are kept the more quickly they burn and the shorter is the flame. If in an unlined furnace the flame of a certain coal extends to a length of 30 feet, it by no means follows that the refractory lining must extend this length, for possibly the lining of about 10 feet would so quicken combustion and shorten flame that a 10-foot length would be all that was necessary. No mere lining of a faulty furnace will make up for incorrect form. Before the water-tube boiler can be made smokeless the gases must cease to rise directly from the fire to the tubes. They must be made to pass along the fire, mixing, as they flow, with the air to burn them, and they must then escape to a brick chamber in which they can burn before they come into contact with the tubes.

The recent trouble in regard to the electric railway power stations in London, which are such great smoke producers, is entirely due to the errors in furnace construction, and no cure is likely to result from any change in the stoking. The bad form of the furnaces was pointed out by the writer long before the stations were even thought of, but the old erroneous designs were persisted in, and the writer does not hesitate to state that less smoke can only be made with the present form of furnaces by a disgracefully excessive introduction of air with consequent waste of fuel. Prevention with economy can only be brought about by a complete change in the furnace design, though it is a matter for regret that where engineers put bad furnaces to their boilers they usually so arrange the boilers and their environment that a cure is difficult, if not impracticable, without costly structural alterations. But it is certain that there need be no smoke even from water-tube boilers, and where smoke is produced it is entirely the fault of the engineer responsible for the design in the laying out of the station. If magistrates who have the law to enforce would go to the trouble of finding out the truth, instead of listening to the rubbish talked about earnest efforts to subdue the smoke by trying patented nostrums and various forms of mechanical stokers, they would probably enforce the provisions of the smoke act in such a way that every electrical station in London would be compelled to do the one thing necessary by building its boiler furnaces of correct form and of proper materials. It is unreasonable to expect a cure of smoke from mechanical stoking alone, though much may be accomplished by them if combined with brick arches.

COWPER-COLES GALVANIZING PROCESS.

At a meeting of the Society of Engineers, November 6, 1905, a paper was read on "The metallic preservation and ornamentation of iron and steel surfaces," by Mr. Sherard Cowper-Coles. The author first referred to the theory of protective metallic coatings for iron and steel, and gave examples of corrosion caused by two metals being in contact, with the presence of moisture. He then described the process of hot galvanizing, or dipping in molten zinc, and some special forms of apparatus employed for the galvanizing of sheets and wire. The next process described was electro-zincing, or cold galvanizing, which consists of electro-depositing zinc from aqueous solutions. A regenerative process was then described and particulars were given of the way in which zinc dust is employed to regenerate the electrolyte and how the voltage between the electrodes is reduced by employing compound anode and cathode bars. Particulars of cost of plant and working the process were also given.



Iron Inlaid with Zinc in Decorative Design, by "Sherardizing" Process.

The greater portion of the paper was devoted to a new process of dry galvanizing or "Sherardizing," discovered by the author. A remarkable feature of this process is that iron and steel can be coated with metallic zinc, by merely bedding it in zinc dust in a drum, placing it in a furnace and raising the zinc to a temperature several hundred degrees below the melting point of that metal. Zinc dust consists of small particles of zinc coated with a film of oxide, and is produced by zinc distillation processes and must not be confused with zinc oxide. When the drum has been charged with the articles to be treated and zinc dust, it is placed in the furnace which is heated to 500 degrees or 600 degrees F., which is some 200 degrees below the melting point of zinc, the thickness of zinc coating being dependent on time and temperature. On opening the drum the articles are found to be covered with a silvery

coating of zinc which has become alloyed or amalgamated with the iron surface. The process of dry galvanizing is found to be cheaper than hot or electro-galvanizing as there is no waste of material, while the expenditure of fuel is small and the plant simple and inexpensive. Particulars were given of the plant employed and a favorable comparison was made of the zinc coating obtained by the new process as against the zinc coating obtained by the hot and cold processes.

An interesting description was given of the application of the process for inlaying and ornamenting metals. The articles to be inlaid are coated with a stopping-off composition, those portions where the metal is to be inlaid and onlaid being removed. They are then packed in an iron box containing the metal to be inlaid in a finely-divided state and heated in a stove. Very pleasing effects were shown to be obtained with steel plates by inlaying them with zinc, the steel being coated with magnetic oxide which renders it rustless. A copper plate can be inlaid with zinc, the thickness of the stopping-off composition being so adjusted that a considerable portion of the copper is converted into a golden colored glass, thus giving a very soft and pleasing effect with great subtlety of color. Zinc may also be obtained on a plain background. By altering the preliminary treatment and varying the length of stoving it is possible to act upon the metal plate so as to obtain, instead of the copper, beautiful color effects varying from silver-white to yellow brasses and bronzes of various shades, graduating to red copper. Among other applications the process has been found useful for case-hardening copper and coating aluminum previous to electro-plating and soldering.

IMPROVED SOLDERING ACID.

Brass World.

A very satisfactory soldering acid may be made by the use of the ordinary soldering acid for the base and introducing a certain proportion of chloride of tin and sal-ammoniac. This gives an acid which is superior in every way to the old form. The method of making it is as follows:

To make one gallon of this soldering fluid take three quarts of common muriatic acid and allow it to dissolve as much zinc as it will take up. This method, of course, is the usual one followed in the manufacture of ordinary soldering acid. The acid, as is well known, must be placed in an earthenware or glass vessel. The zinc may be sheet clippings or common plate spelter broken into small pieces. Place the acid in the vessel and add the zinc in small portions so as to prevent the whole from boiling over. When all the zinc has been added and the action has stopped it indicates that enough has been taken up. Care must be taken, however, to see that there is a little zinc left in the bottom, as otherwise the acid will be in excess. The idea is to have the acid take up as much zinc as it will.

After this has been done there will remain some residue in the form of a black precipitate. This is the lead which all zinc contains, and which is not dissolved by the muriatic acid. This lead may be removed by filtering through a funnel in the bottom of which there is a little absorbent cotton, or the solution may be allowed to remain over night until the lead has settled and the clear solution can then be poured off. This lead precipitate is not particularly injurious to the soldering fluid, but it is better to get rid of it so that a good, clear solution may be obtained.

Now dissolve six ounces of sal-ammoniac in a pint of warm water. In another pint dissolve four ounces of chloride of tin. The chloride of tin solution will usually be cloudy, but this will not matter. Now mix the three solutions together. The solution will be slightly cloudy when the three have been mixed, and the addition of a few drops of muriatic acid will render it perfectly clear. Do not add any more acid than is necessary to do this, as the solution would then contain too much of this ingredient and the results would be injurious.

This soldering acid is used in the same manner as any solution of this kind, but it will be found that it will not spatter when the iron is applied to it. It has also been found that a poorer grade of solder may be used with it than with the usual soldering acid. By experience it has been found that a solder composed of two parts of lead and one of tin works equally as well and produces fully as strong a joint as that obtained with the customary half and half solder.

INVISIBLE PLATINUM WIRE.

S. D. V. Burr, in Iron Age, October 19, 1905.

Some thirty-five years ago the late Henry F. Read, of Brooklyn, inventor of the Gem water meter, made several yards of platinum wire so fine that when wound around a white card it could not be seen except by those having exceptionally good eyes. It could be felt, and the shadow cast by it upon the card could be seen so that its presence was manifest.

The manner of drawing the wire was exceedingly simple. A steel die was first made, the hole being as small as it could conveniently be drilled and polished. Diamonds and rubies were then used for wire drawing, but the steel was easier to handle and answered the purpose just as well. Platinum was then drawn through the die as a first step. A length of the platinum wire was then put in a tube of silver which was passed through the die. A length of the composite wire was again incased in silver and the drawing repeated. After the wire had been passed through the die a sufficient number of times the silver was removed with acid and the invisible platinum wire resulted. At first the drawing was done by hand, but the starts, stops and jerks of this method were found to have a tendency to break the wire, especially when it had become quite fine. This trouble was overcome by providing a little draw bench having a pinion and gear for doing the pulling; the strain was now constant and steady, yet even with this only comparatively short lengths could be drawn. A wire three feet long was thought to be a very successful performance.

The wire was intended for use in making the crosswires in transits, telescopes and optical instruments of like character. The animal fibers employed for this purpose caused considerable inconvenience, principally for the reason that they were affected by slight changes in the humidity of the atmosphere. It was thought the metal would overcome these and other difficulties, but the wire itself possessed defects which were of a far more serious nature and prevented its employment for this purpose. It could be readily inserted and adjusted, and once placed in position it could be relied upon to stay there; but its disadvantages far more than counterbalanced these good points. The prohibitive defect arose from the fact that its surface was too bright. The instrument maker demanded a cross wire that was a dead black—one that was shiny would ruin the accuracy of his instrument. Fibers could be dyed; the metal could not be colored.

The wire manufacturer found he had produced an article which could not be used for the specific purpose for which it had been made, and for which there was no demand in any other direction. He also found that a comparatively few yards of wire would stock the market, as far as the instrument men were interested, and that there was no other demand for invisible wire. He had not produced a commercial article, but he had made a beautiful experiment.

* * *

THE DECEMBER DATA SHEET.

The December Data Sheet contains diagrams and tabulated dimensions of the settings for hung boilers of various sizes, ranging from 36 inches by 8 feet to 70 inches by 20 feet. These dimensions represent the practice of a firm which makes a specialty of building horizontal tubular boilers. The diagrams give a very clear idea of the construction of the supporting walls, combustion chambers, etc. The material was contributed by G. L. Preacher, Augusta, Ga.

* * *

Some years ago an accident occurred in a steel mill in England, causing the death of a laborer; he fell into a mass of molten steel and his body was almost instantly consumed. The ingot was manufactured into steel rails and one of them was buried with funeral service. A parallel accident recently occurred in the Midvale Steel Works at Nicetown, Pa., whereby two workmen were overwhelmed by the escape of 80,000 pounds of steel from a ladle. This ingot was buried November 19 in the shop yard also with funeral service.

A NEW DRAWING PRESS.

A drawing press is now built by the Toledo Machine & Tool Co., Toledo, O., in which there is a new arrangement of the levers and links which transmit the motion of the crankshaft to the toggle joints operating the blank holder. This press is known as their No. 167 and is made under patents recently granted and assigned to this company. The diagram in Fig. 2 shows the link, bell cranks and yoke located on the outside of the frame and operated directly from a crank on the end of the crankshaft. With this movement the required power is obtained with a minimum amount of friction and the result is that an unusually low belt power is required for a press of this capacity. The mechanism is operated by an arm, *A*, Fig. 2, the upper end of which is attached to the crankshaft and the lower end is attached to the yoke, *B*. The lower end of this yoke is guided by a reciprocating link, *C*, pivoted to the frame at point *D*, and the upper end is guided by a link, *E*, also pivoted to the frame. These two links compel the yoke to move in practically a vertical straight line under the action of the connecting rod or link, *A*.

Attached to the yoke are two other links connecting with the bell cranks, *F* and *G*, which in turn are pivoted to the side of the press frame. The outer arms of these bell cranks are connected by long links or rods with cranks on the ends of two rock shafts at the top of the frame, one at the front and one at the rear of the press, from which the motion of the toggle movement of the blank holder is obtained. The engraving, Fig. 2, shows the several parts of the mechanism in their extreme lower position while the dotted lines indicate the position that would be taken when the parts were in their extreme upper position. When the crank which drives the toggle mechanism is in its lower position the blank holder is at its bottom position and

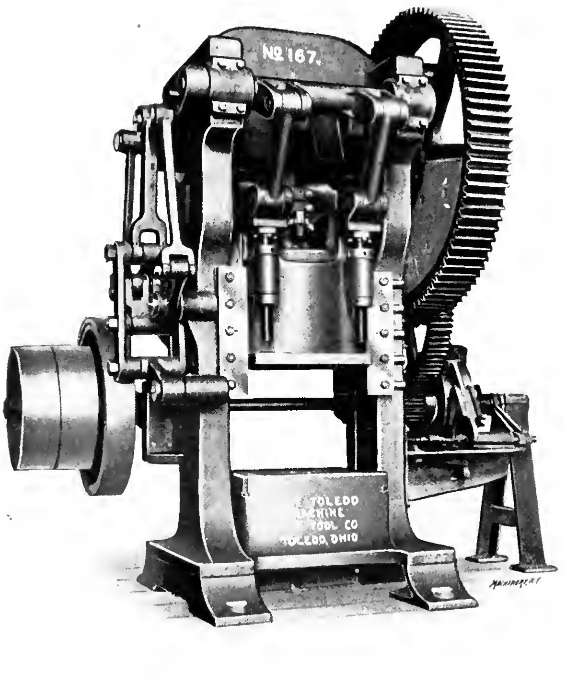


Fig 1. Drawing Press with New Mechanism for Operating Blank Holder.

maintains sufficient pressure on the blank to securely hold it in place while the drawing punch or plunger performs its work. The drawing punch receives its motion in the usual way from the main crank at the center of the crankshaft.

It will be noted that the bell crank levers, *F* and *G*, together with the links connecting them with the rock shafts, form a toggle mechanism which is passing its center at the same time that the driving crank for this mechanism and also the toggle joints connected with the blank holder, are passing their centers; and that this occurs while the blank is being held for the drawing operation. By this means an unusually long

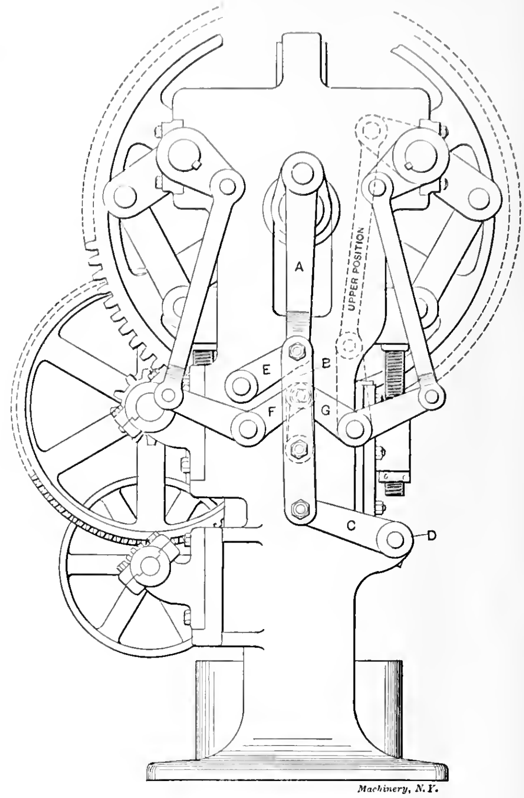


Fig. 2. Details of Toggle Mechanism.

dwell is obtained giving ample time for the blank to be completed before the holder raises sufficiently to release it.

The front and rear rocker arms at the top of press frame operating the inner toggle movement are made of steel. A heavy substantial frame connects the toggle movement and outer slide or blank holder. This blank holder is given a wide range of adjustment by means of the heavy stud or screw at each of the four corners of outer slide. The crank is connected to the inner plunger or forming punch moving inside of the outer slide or blank holder by means of a connection and screw. This connection has a cap held in position by four studs bearing perfectly on the threaded portion of screw, and in this way securely clamping the screw and positively preventing the screw from working loose. The adjustment of the screw is obtained by means of a gear and the adjusting pinion being thrown toward the operator to the front of the press, gives free access for an easy, quick adjustment.

Some of the specifications of the press are: Weight, 44,000 pounds; width between uprights, 35 inches; distance bed to blank holder, stroke down and adjustment up, 16 inches; distance bed to plunger, stroke down and adjustment up, 18 inches; stroke of blank holder, 12 inches; stroke of plunger, 17 inches.

* * *

The largest steamer afloat, in the matter of displacement, is now the *Amerika*, of the Hamburg-American line, which made her first transatlantic trip in October. This great vessel is 684 feet long, 74 feet wide and 53 feet deep. Her displacement is 42,000 tons, and gross tonnage 23,000 tons. She has accommodations for 2,300 steerage passengers and about 1,150 first, second and third-class passengers, besides which she has a crew of 520, making a possible total of nearly 4,000 souls, a population equal to that of a good-sized town. A unique feature of the boat is an *a la carte* restaurant; first-class passengers are given the privilege of buying their passage without meals, paying for their meals as they go. The *Amerika* is a comparatively slow boat, her record for the first voyage being 7 days and 17 hours. The engines are rated at about 17,000 horse power.

THE GEARED DRIVE.

J. C. STEEN.

Whether the geared drive, so called in order to distinguish it from the belt drive by means of stepped pulleys, originated with some machine tool builder who was desirous of improving a given machine, or whether it was first suggested by a machine tool user in an endeavor to secure better facilities for machine operation, it would be interesting to know, but difficult to determine.

Whatever the origin, the geared drive is a response to a demand for a better method of speed variation than could be obtained from stepped pulleys and a movable belt. The gradually growing demand for more powerful machine drives in the past has led to the widening of belts to the maximum point consistent with a desirable number of steps to the pulley and the ease of belt shifting. The limiting point for belt width may be said to be reached when a belt can no longer be shifted easily by hand. For some machines, notably lathes, the maximum diameters of the driving pulleys are generally limited by conditions inherent in the machines themselves.

Back gears were in many instances increased in ratio to make up for what could not be had by further increase of belt widths or pulley diameters, until in some cases the gap between speeds obtained directly by the belt and those obtained through the back gears became too great. When such conditions were reached, obviously, the next suggestion involved the combination of a constant speed belt of such a width and operated at such a speed as to give the requisite power, in connection with some combination of gears to be used for obtaining the desired variation in speeds. Such a combination is, in fact, a reversion of type; a going back to a system of driving formerly much used by foreign builders of machine tools. Many foreign builders objected to the use of stepped pulleys, considering their use as a deviation from, or, as being contrary to, good mechanical practice, preferring in many cases to secure speed variation by means of separate changeable gears. The objectionable feature of such a system did not suit American ideas, hence the early adoption of stepped pulleys and a movable belt as a means of quickly effecting changes even though the device was and is still considered by some designers as anomalous or paradoxical from the standpoint of pure mechanics. The substitution of the variable speed geared drive for the stepped pulley drive is therefore not due to any inherent defect in the stepped pulley so much as to its limitations as previously mentioned, and to a desire for improved facilities for quickly obtaining speed variations.

For belt-driven machines that require a variable speed, the geared drive will probably come more into use whenever its adoption will be justified from a productive or a commercial standpoint. Whatever defects may be existent in any of its varied forms will be tolerated just as long as it meets and fulfills required conditions.

As a device of utility the geared drive has passed the point where it might by some have been considered as a fad. As a matter of fact, scarcely any new device representing a radical departure from generally accepted design and practice has ever been brought out that was not considered a fad by some one. The history of machine tool progress has shown that the fad of yesterday has frequently become the custom or necessity of to-day. Extreme conservatism will see a fad where progress views an undeveloped success.

One drawback to the general adoption of any geared drive is its cost, and this will determine in most cases whether it or a belt drive shall be used; it is a matter requiring careful judgment to determine the point where the results obtained justify the added expense.

An ideal geared drive should have the following features: The minimum number of parts consistent with efficiency, to be so arranged that the least possible number of gears should be in operation at one time; any one of the entire lot of changes should be possible at one movement and without any more shock or jar than with a belt or friction drive; it should be durable, not requiring more attention than a belt drive of equal efficiency; nor should it be more expensive as to maintenance; the design should be such that it can be easily understood and operated without requiring special skill or knowledge on the part of the operator.

That these results are difficult of achievement is undoubted, and necessarily a geared drive, as they are at present designed, adds to the first cost of a machine, as well as to the cost of maintenance.

The advantage of the electric motor as a means of driving machine tools coupled with the expensive method of the earlier systems by which speed variation could be obtained electrically, gave an impetus to the development of the geared drive. To minimize expense and to improve operating conditions, results were sought for by two extreme methods; the aim on the part of the machine tool builder was to design a complete geared drive for use in connection with a constant speed motor, the result being a given variation with a limited number of speeds, while the aim of the electric motor builder was to produce the maximum speed variation in the motor alone, without the aid of gears. These extreme methods have been used in a limited number of instances, but on account of the expense of one and the limitations of the other, they are not well adapted to general requirements.

Leaving the belt drive out of consideration, the question becomes one of selecting such a combination of the electrical and mechanical methods of speed variation as will attain the desired result with the least expense and complication. This leads then to the use of a single voltage and the variable speed motor for moderate ranges of speed variation, and the combination of the same with one gear change for higher ranges of variation. Whether the variable speed motor alone, or the motor and gear combination should be used, will depend upon the requirements. In either case, the desired result can be reached with a minimum expense electrically and the least complication mechanically.

The efficiency of either a belt or geared drive depends largely upon the amount of variation and the number of speeds, together with the facility for obtaining the speed changes quickly. Neither of these methods can be compared with the electric motor with its speeds varied through the controller, particularly as to the number of speeds available, and the ease with which they can be controlled. While a larger number of speeds may not always be necessary, it is desirable that the increment of speed variation be as small as possible in order to obtain the best results as to output.

Until machine tool users realize the advantages of individual driving by electric motors, and this system comes into more general use, the geared drive will be largely used, but it will not displace the stepped pulley until its cost can be brought down somewhere near that of the belt drive of equal efficiency.

The geared drive is in a state of transition as to design and adaptability and machine tool designers are still giving it much thought, but it will probably not reach its best until there is no longer a reason for its existence, owing to the more general adoption of the electric drive.

* * *

For most industrial purposes alcohol is used in Germany, duty free, after having been "denaturized": that is, rendered unfit for drinking purposes by the admixture of ingredients which render it impossible to be drunk, but which do not affect its efficiency for other purposes, especially in internal combustion engines. There are two methods of denaturizing, one of which is complete and the other only partial. The complete denaturization is accomplished by the addition of $2\frac{1}{2}$ per cent of the so-called "standard denaturizer," which consists of 4 parts of wood alcohol and 1 part pyridin to which have been added $2\frac{5}{8}$ ounces of oil of lavender or rosemary for each gallon of the denaturizer. Or use $1\frac{1}{4}$ per cent of the above standard denaturizer and 2 per cent of benzol. The incomplete denaturizer is sufficient to prevent alcohol from being drunk but does not disqualify it for certain other purposes for which wholly denaturized spirits would be unavailable. One method for partial denaturization is to add 5 per cent wood alcohol and $\frac{1}{2}$ per cent of pyridin. Another is to add 20 per cent of shellac containing 1 part gum and 2 parts alcohol. Other methods employ 10 per cent of sulphuric ether, or 1 per cent of benzol, or $\frac{1}{2}$ per cent oil of turpentine.

SOCIAL FEATURES OF THE WESTON ELECTRICAL INSTRUMENT CO.'S SHOP.

The shops of the Weston Electrical Instrument Co. of Newark, N. J., present some interesting social features. The plant is located in the outskirts of the city on the line of the Pennsylvania Railroad, and was built about five years ago. It is difficult in making a general survey of the appointments of the establishment to know just where to draw the line between the purely social and purely commercial features. Probably no such line can be drawn. Everything which contributes to the relaxation of the workman outside of working hours as well as that which enhances his comfort while he is at work has a strictly utilitarian value. The shops are well lighted, well heated, scrupulously clean, and supplied with fresh air. All these things of course work equally to the advantage of employer and employee. Besides these points, which are generally considered in the design and construction of modern shop buildings, there are a number of other features in which the direct connection between the outlay and the income is not so apparent. Most of these features are centered in a large four-story building at present unused, with the exception of one floor, for other purposes.

Fig. 1. Employee's Dining Room, Weston Electrical Instrument Co.

When the shop was erected, the second floor of the building was fitted up as a dining room with every convenience for the preparation and serving of wholesome food at reasonable prices. In the accompanying half-tone, Fig. 1, is shown a view of this room. The ceiling is lofty, the walls are painted in cheerful light colors, the chairs and tables are of polished wood, and when the tables are set for luncheon, the white napkins, with the silverware and crockery, present an inviting appearance.

Fig. 2 shows a view of the kitchen. Its equipment compares very favorably with that of a first-class club or hotel. The center table contains a row of steam kettles; on the table in the left-hand corner is a bread grinder for use in making croquettes, dressings, etc.; sinks, shelves, chopping blocks for cutting meats, and a steam kettle for washing dishes are placed at convenient points.

On this floor is also a library containing an assortment of scientific books, the gift of Dr. Weston, the president of the company, together with a large number of works of fiction, travel, poetry, essays, etc., from the Newark Public Library, of which this has been made a branch office. Adjoining the library is a small dining room where at a large table the heads of the various departments gather for the mid-day lunch, having thus an opportunity to talk over matters of interest in the management of the concern. A still smaller dining room is fitted up for the use of the directors. Both of these rooms are served from the same bill of fare as that used by the employees.

On this floor, in an ell extending in an easterly direction, is a room which has been fitted up for an assembly hall. At least once a month or thereabouts during the winter, entertainments, dances and lectures are held here. The firm employs quite a large proportion of girls and women in the shops, so these affairs can be carried out successfully without calling for outside assistance. A large number of games is provided—billiard and pool tables, chess, checkers, dominoes, etc., fencing and boxing sets, and a baby grand piano and pianola. The unique feature of the equipment is located on the ground floor of this building. A large storage tank was necessary for a supply of water for fire protection, and a virtue was made of this necessity by giving this tank the form of a natatorium. This is shown in Fig. 3. It is 150 feet long by 18 feet wide with a depth varying from 4 to 9 feet. Its sides and bottom are formed of glazed tile work, as are the sides of the whole room in which it is built. This swimming tank is larger than the largest in any private club in the country, and the shower-bath, needle-bath, toilet arrangements, etc., with which the room is provided, do

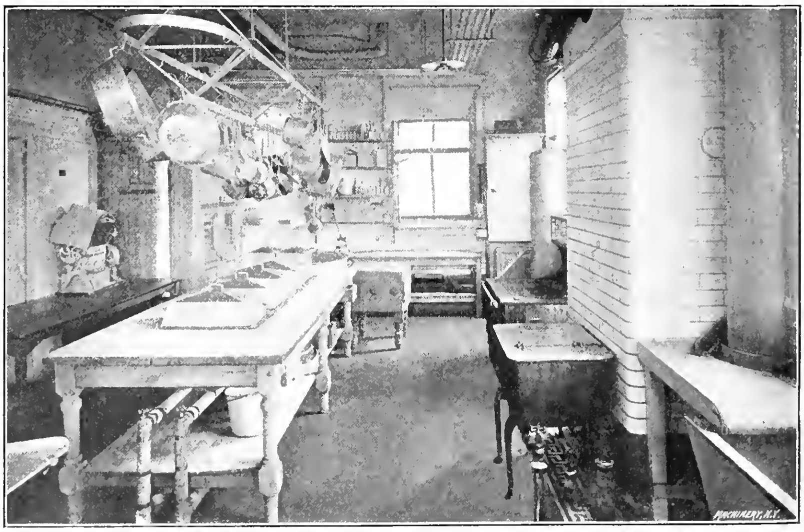


Fig. 2. Arrangement and Appointments of Kitchen.

not suffer in comparison with the best to be found elsewhere. At certain hours on specified days of the week this room is at the disposal of the female employees. During the summer when the shop base-ball team is playing and later on in the season when the foot-ball enthusiasts get busy, the bathing accommodations, dressing rooms, etc., are a great convenience.

The workmen take an active interest in the fortunes of the shop base-ball and foot-ball teams. The company owns 27 acres of land stretching in a diamond-shaped tract toward the southeast. A part of this land has been fenced off to form a ball field and the employees have built a grandstand which is being paid for by the small fees which are charged for seats therein during the games. A little further over are tennis courts that are in demand during the summer.

The vital feature of the "betterment" work of the Weston Electrical Instrument Co., lies in the way in which these various activities are carried on. After the equipment which we have described had been completed, the dining room, assembly room, etc., furnished, and everything put into running order, the whole thing was turned over to the employees as a gift, and since that time the company has taken no active part in its management. With the equipment went a working capital of $1,000. This is all under the control of the "Weston Employees' Club," in which any person employed by the company is eligible for membership. The dues are twenty-five cents per month with an initiation fee of twenty-five cents.. About eighty per cent or thereabouts of the total help employed belong to the club. The institution has been running for over three years and it is perhaps safe to judge now as to its ultimate success. At first the cuisine was turned over to a caterer with the result that after running a while, the service, cooking, and the finances all became equally unsatisfactory. The first caterer was released and another one tried in his place and the same result followed. Finally the club took the management of the kitchen into its own hands, hiring a competent chef with assistants for preparing the food and serving it. Since that time the dining room has been self-supporting.

The company pays the club for the meals served to the directors and the heads of departments, twenty-five cents per plate being the amount turned into the treasury each day. The members of the club get their luncheons for ten to twenty cents, depending on whether or not they take the full bill of fare. If desired, the meal may be ordered a la carte.

This luncheon is served by volunteers from the shop who are paid therefor by being allowed their meals free, the company granting them extra time for this purpose to insure their having a full forty minutes noon recess.

The establishment labors under great disadvantages so far as the social side of the club is concerned. Few, if any of the workmen, living as they do in Newark and Elizabeth, have homes within two miles of the plant. This means that for evening socials and dances the members must take a night trolley ride to the outskirts of the town. There is thus a tendency to center the activities of the club in the dining room feature, but in spite of this great handicap a number of social events occur each year, averaging probably about one a month, and these events are thoroughly enjoyed.

As before stated, the company has entirely resigned the management of the club into the hands of the workmen. The $1,000 which was the original capital was given with the understanding that when that was used up there would be no more forthcoming. On two or three occasions since the institution was established, the treasury balance has reached a pretty low point, in one case at least becoming a minus quantity. A little friendly encouragement on the part of the proprietors in times like these has been sufficient to renew the interest, bringing up the treasury balance to a sufficient working point. One feature of the management is especially noticeable. Beer is served at luncheon and at all the entertainments and social functions, but there has been no evidence of a tendency to abuse this privilege. At luncheon where no restrictions are imposed on its sale, scarcely more

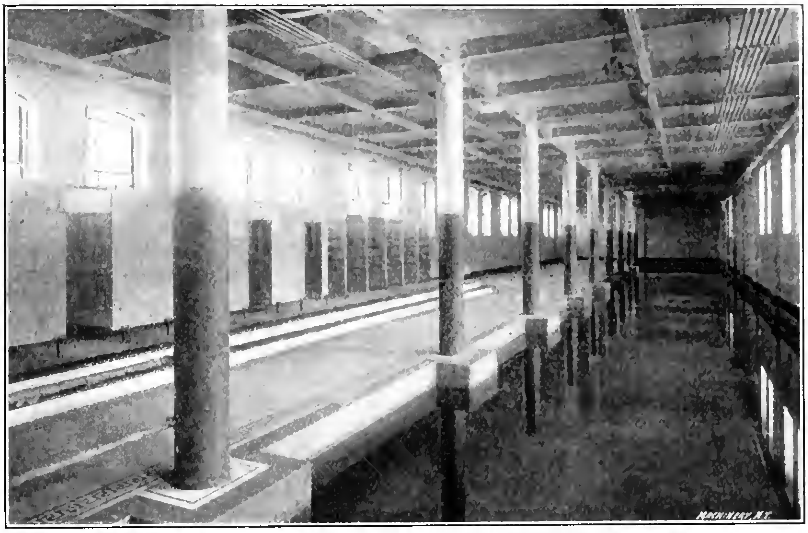


Fig. 3. Swimming Tank.

than a dozen or fifteen bottles a day are consumed. At dances and entertainments the beverage is served from an improvised bar in a curtained corner of the room, but it is invariably indulged in with moderation and there has never been any reason for limiting the sale. Again, it is interesting to note that the costly toilet equipment, an example of which may be seen in Fig. 3, with which the plant is supplied has not been defaced or mis-used in the slightest degree. In planning the details of the equipment Dr. Weston gave this matter considerable thought, and determined on the course he ultimately followed against the advice of nearly everyone with whom he talked the matter over. After making a tour of the hotels, clubs and public institutions in New York city, however, he became convinced that where the best facilities were provided, those who made use of them were careful not to injure them, but that cheapness and slovenliness in the original design and construction was invariably an invitation to vandalism. The attitude of the firm in this and other respects, for instance, the equipping of the entire plant with the most modern sanitary plumbing at a cost exceeding by two or three times that required to place it on a par with average establishments, is distinctly different from that assumed by concerns which have adopted the paternal attitude toward their employees, and on the whole this display of confidence seems to have met with the expected degree of appreciation.

* * *

In many manufacturing establishments it is now the common practice to prepare lists in the drafting room of the parts comprising a machine, giving at the same time the name, drawing number, pattern number, material, etc., for each piece and the number of pieces. The B. F. Sturtevant Co., of Boston, Mass., was one of the first to introduce this system by the use of so-called "production-lists" printed on thin paper with the different items lettered in black ink so that blue prints in any quantity can be taken for distribution. These form the basis for production, casting, purchase and other orders. The original is retained as a permanent record of the details of each machine, simplifying reproduction and the filling of repair orders upon obsolete designs.

LETTERS UPON PRACTICAL SUBJECTS.

FILING UP ENGINE CRANKS.

Editor MACHINERY:

In "doctoring up" a number of old engines a surface block for use similar to using a flat surface-plate has suggested itself to me which may be interesting or useful to others when truing up cranks. The first case where the crank required attention was that of a cross-compound engine with center cranks forged solid with the shaft and on opposite sides, or 180 degrees apart, so as to make one set of reciprocating parts counterbalance the other, and permit of running at high speed. Although this engine had only run some two years it was "pounding" and was said to have run badly from the start. It seemed that the shaft was stiffer in one direction than in the other and sprung away from the lathe tool more when turning one quarter of the crank than when turning the next quarter, and thus produced an oval crank which grew worse in service.

Securing an old crank "brass," I pinched it together a little and rebored it to a diameter about half way between the old diameter and that which was to be the new one. With this

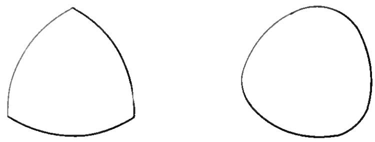


Fig. 1 Fig. 2

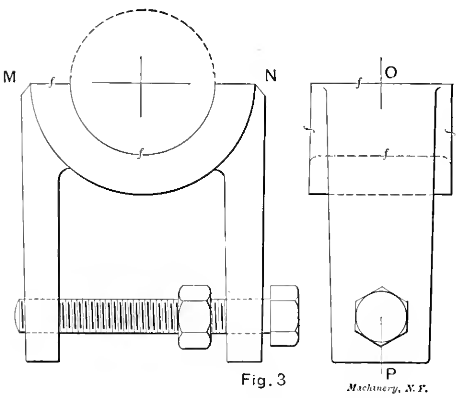


Fig. 3

Filing up Worn Crank Pins.

rebored brass, a pair of calipers, straightedge, etc., I expected to file up those cranks truly round and straight in a manner similar to that of scraping a flat surface to a flat surface-plate. But my half-round "surface-plate" was not entirely successful in that it was adapted to only one size, while the two cranks were not exactly the same diameter to start with and these diameters gradually grew less as the high spots were worked down. Nor were the calipers an infallible guide, for when a high spot on one side came opposite a low one on the other the calipers might not indicate anything wrong. However, by exercising some patience and spending considerable time, the job was gotten into fairly good shape.

The next case where the crank required attending to was that of an ordinary Corliss engine with a crank-pin inserted in a cast disk on the end of the shaft. In this instance, there was, of course, no doubt but that the crank had been all right when the engine was new some eleven years before. Profiting by my former experience with the old "brass" for a test plate the new one was made of cast iron in the form shown in Fig. 3. By means of the tap-bolt through the two lugs on the back, the working diameter of this could be adjusted to suit the crank-pin. In making the pattern, provision should be made to part the mold on either the line *M N* or *O P* so that the ends are equally flexible.

This flexible curved test plate was carefully bored to about the diameter that the crank would finish to and then pulled out by the bolt to just the diameter wanted for trying the crank. And then, as the crank worked smaller, the bolt was slackened to suit, or, if the size went slightly below normal, the nut shown was brought into use. This adjustable test plate proved much more satisfactory than any rigid one could have been, and enabled a better job to be done in about half the time required when using the rigid test piece.

Although there are portable machines in use and on the market for re-turning cranks in place, I am of the opinion that for many cases of stationary engines, at least, filing them true is the better and cheaper way. Filing should, however, be done by one who is accustomed to filing and scraping and not by the one who spends the other 364 days of the year at shoveling coal.

If there are some few readers of this paper who have implicit confidence in their new calipers to show them whether a piece is round or not let them try those calipers (yes, micrometers or any kind of calipers,) on Figs. 1 and 2, and also try those same figures with a pair of compasses.

Milwaukee, Wis. JOHN D. RIGGS.

SETTING UP AN ENGINE LATHE.

Editor MACHINERY:

For the past three years I have been operating a 20-inch swing 10-foot bed Reed engine lathe, and have had more or less trouble with it when doing fine work on account of its not boring or facing true.

When I first began running it, it was new and just set up. It bored 0.007 or 0.008 inch per foot large at the chuck end of a cut, and faced about the same amount concave. This decreased in a short time to about half the amount and did not bother me seriously on ordinary work. After about a year, I began to get work that called for a plug gage fit at both ends of a six-inch bore. At first I reset the tool two or three times during the cut and then scraped the bore to fit. This operation being tedious, and thinking that the cause lay in the alignment of the arbor, I filed about 0.01 inch off the box at the small end of the arbor and shimmed it over. For a time the lathe bored true and faced nearly true, but after this I found that sometimes it would bore small at the chuck end and sometimes large.

The lathe was set up on a 1½-inch maple floor crossing 3-inch hemlock planking laid on tamped cinders. At times there would be piled on the floor at one end or the other, either in front or back, a ton or more of castings. About six months ago the lathe was moved to another shop and set up. The first cut that I took in the new shop was on some work that required a true face. The cut was convex and I removed the shim that I had placed in front of the small box and placed it on the other side, thus bringing the box back to its original position, when the lathe faced practically true. It then occurred to me that the variation was due to the leveling up of the lathe on the floor, and the changes had been due to the pressure of the castings piled around it.

Some time later the lathe next mine was removed for the purpose of fitting it with a motor drive, and on its return I noted the manner in which the millwrights set it up. The floor was uneven and required wedges under three legs of the lathe. The millwrights did not bring shingles with them, but obtained pieces of ¼-inch and ⅜-inch boards. They found that the ¼-inch piece was not quite thick enough under the third leg so took it out and replaced it by a ⅜-inch piece. When they had finished I placed a level on a piece of key steel on the carriage and found that the bed was warped about 0.025 inch—the travel of the carriage. A few days later I had an opportunity to use the lathe and found that it did not bore or face true within 0.003 or 0.004 inch to the foot.

My lathe had been removed for motor drive and when the millwrights were setting it up again I asked them to be careful not to warp the bed. After they were gone I found that it was warped considerably over 1-32 inch and promptly removed the leg screws and shimmed up one of the legs until a

level would not vary in the travel of the carriage. I then faced a piece of work and found that it was as nearly perfect as one could wish.

I am in one of the largest machine shops in the country and all through it there is complaint about the lathes not being true. Probably 90 per cent of the lathes in the works have more or less warp in their beds from imperfect leveling in setting up, and in being screwed down to the heavy flooring. I find that my lathe will take a much heavier cut without chatter since the bed was made level. Without doubt a great deal of this trouble, in every machine shop, is due to the uneven pressure of the head and tail stock and carriage on the ways, caused by the warping of the beds.

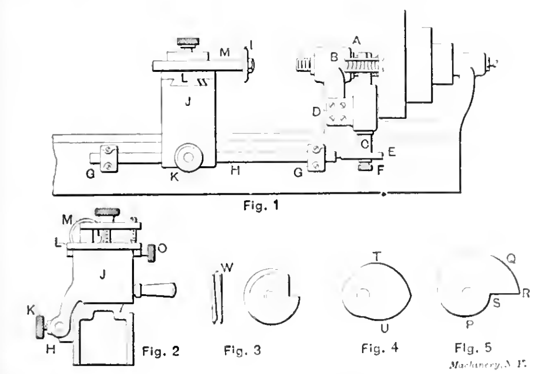
Schenectady, N. Y. ROBERT MAYHEW.

A THREADING ATTACHMENT FOR THE SPEED LATHE.

Editor MACHINERY:

Enclosed you will find a sketch and description of an attachment for rapid and accurate thread cutting on small brass pieces. It is especially adapted to the use of those engaged in the manufacture of small threaded parts required on scientific instruments, especially on small photographic and microscopic work.

Fig. 1 shows a rear view of the lathe with the mechanism of the thread-cutting device. Mounted on the spindle as shown at *A* is a worm. For the general run of instrument work covering a range of from 20 to 100 threads per inch, I have found that a pitch of 10 threads per inch is about right for this worm. *B*, a worm wheel meshing with it and keyed to the vertical shaft *C*, should then have 40 teeth. This vertical shaft, *C*, is mounted in a bracket, *D*, fastened to the rear side of the head stock, and carries at its lower end a cam, *E*, held firmly in place by a knurled nut, *F*. Through brackets, *G*, on the rear of the bed slides a bar, *H*, with a contact plug at the end adapted to be controlled by cam *E*. Slide *J*, which



Details of Threading Attachment.

rests on top of the bed of the lathe, may be fastened to this bar at any point by a knurled set-screw, *K*. Fig. 2 shows a side view of this carriage. At the front side of it a handle projects which allows it to be raised when necessary, swinging about rod *H*. The upper part of the carriage is adapted to receive the tool slide, *L*, to which is clamped the threading tool *I* and holder *M*. A knurled screw, *O*, provides for the adjustment of the tool for depth of cut.

In operating this device, a cam of suitable contour for the pitch desired is mounted at *E*. The work is held in a spring-collet, three-jawed chuck, or any of the usual devices, which may be screwed to the end of the spindle. The circular thread tool *I* is, contrary to the usual practice, mounted at the back side of the work and threading is commenced at the end of the thread nearest the head stock, the cut running out at the front of the piece, which is also contrary to the usual practice. As the lathe spindle revolves, cam *E* will revolve at a slower rate, pushing out rod *H* and carrying the slide with it in such a fashion as to cut a thread of the predetermined pitch. If the thread is long enough to require the whole throw of the cam, the lathe spindle is not reversed at all. Using the cam, for instance, shown in Fig. 5, the tool would commence to cut at *P*, and continue cutting perhaps around to *Q*, when the carriage would be lifted by means of the handle and brought back by hand again to *S* as soon as the contact plug had cleared the high point at R. For this second cut the workman brings the slide out slightly by means of thumb-screw *O* to take a little deeper chip. It will be seen that the tool will thus cut up very close to the shoulder, since its motion toward the head stock is absolutely arrested by the "dwell" on the cam from *S* to *P*. While the contact point is resting on this part of the cam, the threading tool will be cutting a recess. For the coarser pitches it is entirely practicable to have two pitches on one cam, as shown in Fig. 4. If it is desired to cut a right-hand thread of a pitch made by side *T* of the cam, it is placed in the machine, the side up shown in the sketch. If it is desired to use the other side, *U*, of the cam, the cam is reversed and a different pitch thread will be cut. For short-length threads, it will save time if a treadle attachment for reversing the spindle motion is provided. This will allow the contact point to run up on the cam the required distance, and then upon the reversal of the movement, controlled by the foot of the operator, the cam will turn backward bringing the tool back to the starting point again. This allows the hands of the operator to be free to raise and lower the carriage and adjust the tool for each cut.

The circular formed thread tool *I* may be made as shown in Fig. 1, in which case one tool will do for almost any pitch, or it may be given the form shown in Fig. 3. Here the cutter is threaded to correspond with the pitch of the thread it is desired to cut, and when the sides are trimmed off the tool is left wide enough, as shown at *W*, to trim the tops of the threads. This is especially valuable if the stock is a little over-sized. For cutting right-hand threads, the tool should be threaded left hand; for cutting left hand, the tool should be threaded right hand.

This attachment has several advantages over cutting with a leadscrew or tap and die. It saves time on making single pieces on account of the ease with which the cams at *E* may be changed to suit the pitch desired, especially since two pitches may be made on the same cam. Again, it is not always necessary, especially on comparatively long threads, to reverse the spindle. A suitable recess is always cut for the thread to run out into. The lifting of the carriage avoids the necessity of screwing the tool out at each cut, and lastly the arrangement is such that back lash is entirely avoided, the thrust of the cam *E*, controlling the carriage by a direct thrust through rod *H*. R. H. FUERLE.

Philadelphia, Pa.

"HEROIC METHODS OF DOING WORK."

Editor MACHINERY:

The point of view which Mr. Griggs takes in discussing the above topic in the November issue is a very natural one if, as I infer, he is an engine man, or if he is a toolmaker. Also the saying that "What is worth doing at all is worth doing well" is very true. But where people differ is as to what doing a job well means.

I remember that in the old shop we used to fit up a good many derrick gears. These consisted of a wooden drum on a square shaft with a cast gear and another shaft with a pinion and squared ends for the cranks. These shafts ran in split cast iron boxes which in turn were bolted to a frame made of more or less seasoned hard wood. We had a new man come in to fit up some tools, reamers among them, for we had never had anything of the kind before. About the time he had the job done an order came along for four sets of derrick gears. This new man had seen some of these gears fitted up and had shown quite plainly that he considered them a bum job. The Old Man set him to fitting them up. He reamed out the boxes with his new reamers and he water-polished the journals to the nicest possible fit. Well by-and-by they got bolted to the wooden frames and then the fun began. The Old Man had something that kept him busy off at the other end of the shop all the morning, but we could see him glancing over toward the job out of one corner of his eye, but he let Mr. Man fool over it till after dinner. Then

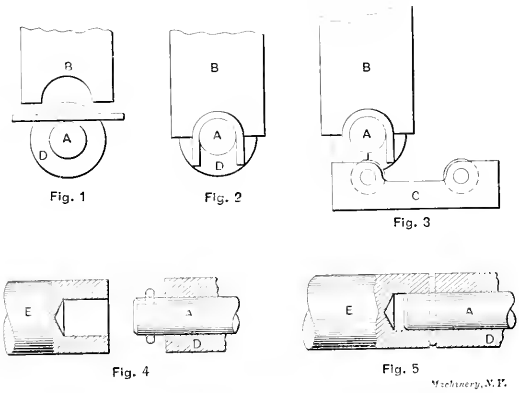
he had him turn a thirty-second off the journals so they would run. And by that time Mr. Man was glad to do it and get the job off his hands. A shaft a thirty-second inch loose in its box looks about an eighth to a toolmaker, but it was just about enough so that the gears could be turned over in the spring after they had been out in the quarry all winter.

Now this job was worth doing and it was well done, but it would be hard to convince lots of people that it was fit to go out of the shop. There is a tremendous lot of work done which must be done in ways which a tool man would consider "heroic" in order that it may work at all, and you people who publish mechanical papers are responsible for some of the lack of understanding on that score, and the technical schools are responsible for more. What you publish, naturally following the line of least resistance, relates mostly to "nice" work well done from the tool builder's point of view, so that to your readers a job done by the "heroic" method is apt to cause comment out of proportion to its importance. Almost every shop, even those doing fine work, has at least one man on whom they rely to get them out of tight holes in a hurry, and while they may look down on him between whiles they know his value well enough when there is an accident. "ENTROPY."

A NOVEL METHOD OF MAKING WASHERS.

Editor MACHINERY:

I recently saw in the shop of the American Wire Washer Co. of Unionville, Conn., a washer and process of making same which seemed to be novel and interesting. The material used by this process is wire, as is indicated by the corporate name. For the regular washers, round wire is used, for lock washers, square wire, and special washers may be made from any shape that would best suit the purpose, though a round section meets the requirements in most cases. By this process the waste of material is very small, from 6 to 10 inches only



Cycle of Operations in Making a Wire Washer.

of wire being lost at the end of each coil. This saving of material is quite an item, for by the old method about one-half of the stock goes to scrap.

The machines for making these wire washers are automatic, and from six to ten may be run by one operator. I was unable to obtain photographs to show the working of the machine clearly, but the following sketches will explain the operation of the dies. In its general appearance the machine resembles the ordinary automatic wire forming machine.

The stock is unwound from a reel, and passed first through a rotary straightener to take out the kinks. It is next cut in the proper length and deposited in position over a protruding circular plug, *A*, as may be seen in the face view, Fig. 1. A bending die, *B*, next comes down over it, giving it an inverted U outline. A slide, *C*, underneath the plug now comes up, moving first to the left and then to the right, in such a manner that the lower ends of the wire are bent around the plug by the rollers to form a complete circle. This operation is shown partially completed in Fig. 3. Figs. 4 and 5 are sectional views, plug *A* being the same here as in Fig. 1. Slide *B*, now withdraws and, as shown in Fig. 4 a female die, *E*, advances and mashes the wire into the shape of a flat washer, making it without any waste of stock. Die *E* then recedes, plug *A* is withdrawn within sleeve *D*, and the completed washer being thus stripped, falls into a box below the machine. The whole process is carried on with great rapidity.

These washers, the process, and the machinery, are patented by the inventor, Mr. H. Chauncey Hart, who conceived the idea when working at a factory where washers were being made from sheet stock. His attention was drawn to the amount of waste entailed by this process. When he went home at night he bent up a ring from round wire, flattened it with an improvised die, and had a good washer with inner and outer edges rounded and free from burrs.

Chicopee Falls, Mass. J. R. RAND.

CROSS-PLANING GAP LATHE BEDS.

Editor MACHINERY:

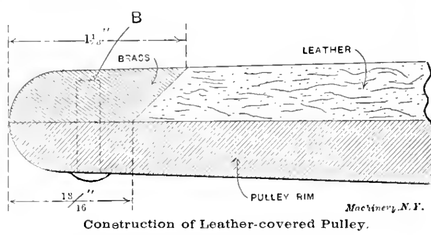
Mr. Fay's description of how he planed out a gap bed was very interesting to me as it is a job that I have had a chance to experiment with. The first time, we did it the way he shows except that we had relays of laborers to furnish motive power. We planned then to rig up a counter shaft and do it by power, but the next one came along before we got rigged up so we took the crossrail off a 38-inch planer and bolted it on across the end of the table, laid the bed on blocks on the floor and went ahead as if we had a shaper. To get the quick return right we had to reverse the planer, and since the planer was rather low we had to set it up on skids. The next bed we put around back of the planer so as to save reversing it, but we had no crane there and it was a great bother to jack up a ten-ton planer and set it down again, so a little later we tried another way. We put the beds on crosswise of the big planer but instead of a greased way such as Mr. Fay speaks of we made up a good solid iron wheel truck and a short track for it to run on. The track was framed up so as to be solid and substantial. We set the track and truck so that the part of the bed which overhung the planer table was balanced over them, and wedged up the bed on top of the truck so that the truck carried the weight. Then we went ahead just as with any planer job. No more strain was brought on the planer than with the same bed put on lengthwise. There was a slight trembling of the far end of very long beds at the instant of reverse due to the momentum of the bed and its lateral springiness, but it was never enough to bother. E. H. FISH.

Worcester, Mass.

LEATHER-COVERED PULLEYS.

Editor MACHINERY:

When in the design of machinery it is desirable that the pulleys shall be covered with leather in order to obtain the maximum adhesion of the belts, I would recommend that the following directions be followed; a pulley leather covered in this way is neat in appearance and a first-class job. This construction protects the edges of the leather covering from injury by accidentally coming in contact with tools, scaffold boards, ladders or any other obstruction likely to be placed against them



Construction of Leather-covered Pulley.

by careless workmen. Like all other good things in mechanics, the first cost will be against it, but the adhesiveness of the leather covering, and its durability, when applied in this manner, make it very economical in the long run.

For a pulley of large dimensions having to be covered with rather thick leather, I would make the pulley 2¼ inches wider than the width of the covering, measured from the edge of the pulley to the bevel edge of the leather covering, as shown in the cut. After the covering is secured to the face

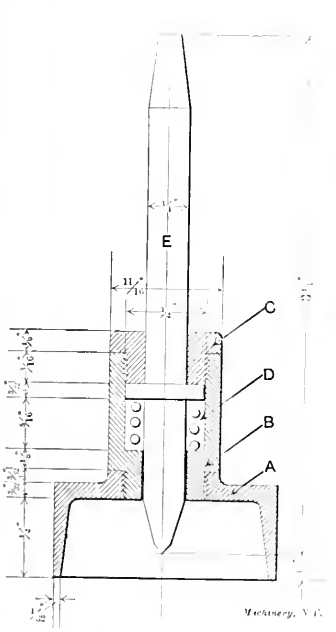
of the pulley by glue and rivets in the manner described by me in the July, 1905, issue of MACHINERY, the pulley should be put on the lathe and the edge of the leather beveled true with the edge, making the angle next to the pulley 13-16 inch from the edge and the top surface about 1⅜ inch from the edge. A strip of rolled brass ¼ inch thick and 1⅜ inch wide is beveled at the same angle as the edge of the leather and rounded on the outer edge on the upper side. This is drilled and counterbored for 3-16-inch rivets, copper rivets being preferable. The holes should be about 2 inches apart and should be countersunk on the face side. The rivets are headed over on the inside of the pulley rim. The beveled edges of the brass bands bind the edges of the leather and hold them tightly to the face of the pulley. Thus the metal guard not only protects the edge of the leather, but it adds to its adhesiveness to the pulley and gives a neat and mechanical appearance which is unsurpassed. For smaller pulleys proportionately smaller bands and rivets can be used. A leather cover put on in this manner should last for years, and should it ever need renewal the brass bands can be taken off and a new covering put on and bands replaced readily enough where ordinary repair tools are at hand. C. E. MINK.

Syracuse, N. Y.

A SELF-CENTERING CENTER PUNCH.

Editor MACHINERY:

As the name indicates, this is a punch for finding the center of a circle, given its periphery. Such an instrument would mean the saving of time in laying out work of such a character. Especially is this true in connection with flanged work of any description, where one flange, having been drilled, is laid upon its companion for marking off the corresponding holes. Now, in order to accurately find the center of these marked holes, without waste of time in "quartering" each one, requires an exceptionally keen eye, especially with holes 1¼ inch diameter and above. But with the "self-centering" punch illustrated herewith any one can readily mark the centers in at least one-quarter of the time which is required by the old method. Of course this instrument would be most useful in cases where there are no jigs used, as on special work, etc.



Self-centering Center Punch.

The construction is as follows: A set of cups, *A*, should be made for, say, 1¼, 1⅜, 1½, 1¾ and 2-inch holes, the diameter (outside) of said cups being approximately ⅛ inch less than the holes in the templets used for marking. These cups, as well as all of the material used in construction, except the spring, should be of good machinery steel, case-hardened. Into cup *A* is screwed the sleeve *B*, containing the spring *D*, and threaded at the top to receive the cap, *C*; *B* and *C* act as guides for punch *E*. The collar on punch *E* may be made adjustable, in order to allow punch to be lowered as point is ground off; this, however, is hardly necessary, as this tool should not receive rough usage, being used simply as a marker.

This makes a very handy and time-saving tool, it being necessary simply to unscrew *A* from *B* in order to change for different sized holes. CALVIN B. ROSS.

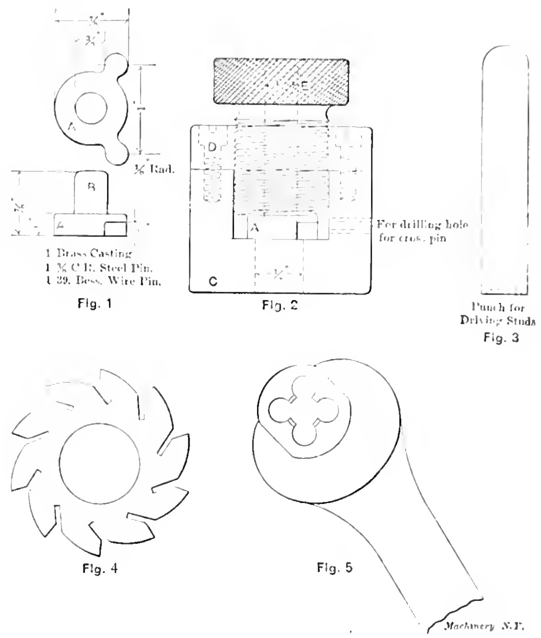
Springfield, Ohio

DRILLING AND ASSEMBLING JIG—MILLING CUTTER FOR CLOCK GEARS, ETC.

Editor MACHINERY:

The accompanying cut, Fig. 2, shows a view of a combined drilling and assembling jig which was designed and made for the purpose of facilitating the manufacture of the part shown in detail in Fig. 1. It consists of a brass casting *A* having a small machine-steel stud *B* driven into its center and securely held against turning by a small bessemer wire pin through both casting and stud.

During the ordinary course of manufacturing with a plain drilling jig some difficulty was experienced in driving the studs squarely into the casting, thereby making it impossible to replace the pieces in their proper position in the jig in



An Assembling Jig, a Milling Cutter, and an Old-fashioned Die Holder.

order to drill the small pin holes. To overcome this difficulty and insure the production of interchangeable work the above jig was designed to drill the necessary two holes before removing the part from the jig. It is very simple in construction, consisting of cast-iron body *C* and a soft steel cover *D* fitted with a tool steel screw bushing *E* for locating and fastening the casting in its proper position for drilling.

To relieve the shearing strain on the small cross pin it is necessary that the ⅜-inch hole shall be drilled a trifle small in order to make a good fit on the stud. This is accomplished by using a ⅜-inch drill that has been almost entirely used up and is therefore about 0.373 inch in diameter, thus avoiding the use of letter size or other drills that are not standard. After drilling, the jig is turned bottom side up and the stud inserted through the ½-inch hole in the bottom and driven home with the aid of the punch shown in Fig. 3. This is simply a piece of ½-inch drill rod having a groove turned at one end to clear the burr made by the drill. It is evident that when driven in this manner the stud must go in square and when the punch strikes the brass casting in the jig the stud has been driven to its proper depth, that is, flush with the bottom of the brass casting. The small pin hole is then drilled and the finished part removed by unscrewing the bushing. The simplicity and ease of operation of this jig make it a good producer and its application to other jobs of similar nature has been decided upon

The small gear cutter shown with slots cut ahead of the teeth has recently been successfully used by firms having large quantities of brass or bronze gears to cut. The purpose of the slot is to provide clearance for the point of the bevel edge emery wheel used in sharpening the cutters. It reduces

the amount of hard steel which must be ground away and helps to keep the faces of the teeth radial.

The socket die holder described by Mr. Casey in the September issue is a worthy tool, its only weakness being the small headless setscrews. Having had trouble with these we made a socket on the same principle as the socket tap wrench and this has so far been good to us. But sometimes where space is extremely limited we are driven back on the good old-fashioned way of grinding two flats on the side of a round die and using an ordinary 15-degree drop-forged wrench to turn the die, as shown in the sketch.

New York. H. J. Bachmann.

[The shape of milling cutter shown by Mr. Bachmann was finally adopted by one concern making large numbers of small brass gears, to mitigate the trouble caused by girl operators carelessly dulling the cutters. At first the tool room kept the cutters sharpened, but so great was this work that it was resolved that the girls should be made to do it themselves so they would be more careful about running the cutters into the arbors, etc. By making the teeth of the peculiar shape shown the labor of grinding is reduced and there is less tendency to grind the cutting face slanting backwards. This is an example of reverting to what is generally regarded as uneconomical practice, *i. e.*, making each employe sharpen his own tools, but for very good and sufficient reason apparently. —Editor.]

HORSE POWER OF DETACHABLE LINK DRIVING CHAIN.

Editor Machinery:

The accompanying table lists the horse powers of driving chains, comparing the link belt with Jeffrey Mey-Oborn chain, which are both about the same size, as they will work on the same sprocket wheels. The horse-power of driving chains is a subject which I have never been able to get very much satisfaction on, as the makers stand to the working strain in their

HORSE POWER OF DETACHABLE DRIVING CHAINS, SPEEDS GIVEN IN FEET PER MINUTE.

This Table gives values for ideal conditions. For ordinary duty deduct from 30 to 40 per cent.

Detachable Link Belt.				Jeffrey Mey-Oborn.			
Trade No.	Working Strain, No. Lbs.	Horse Power. 250 Feet	Horse Power. 500 Feet.	Trade No.	Working Strain, No. Lbs.	Horse Power. 250 Feet.	Horse Power. 50 Feet.
25	75	.56	1.125	25	100	.75	1.50
32	150	1.125	2.250	......	......	......	......
33	200	1.50	3.000	33	250	1.12	2.25
34	225	1 68	3.375	34	250	1.12	2.25
35	250	1.87	3.750	......	......	......	......
42	300	2.25	4.500	42	400	3.00	6.00
45	350	2.50	5.025	45	400	3.00	6.00
51	375	2.81	5.625	50	250	1.12	2.25
52	500	3.75	7.500	52	600	4.50	9.00
52½–55	450	3.37	6.750	55	600	4.50	9.00
57	600	4.50	9.00	52 spec.	800	6.00	12.00
62	650	4.87	9.75	57	700	5.25	10.50
66–67	700	5.25	10.50	62–67	750	5.62	11.25
75	750	5.62	11.25	75	1000	7.50	15.00
77	800	6.00	12.00	77	900	6.75	13.50
78	1000	7.50	15.00	78	1100	8.25	16.50
83–88	1200	9.00	18.00	83	1500	11.12	22.25
85	1300	9.75	19.50	85	1600	12.00	24.00
95	1600	12.00	24.00	88	1300	9 75	19.50
103–108	1800	13.50	27.00	103–121	2000	15.00	30.00
114	2000	15.00	30.00	108	2200	16.50	33.00
104½	2100	15.75	31.50	122–146	3000	22.50	45.00
122	2200	16.50	33.00	124	4000	30.00	60.00
124	2250	16.87	33.75	......	......	......	......

$$\text{Formula used: } \frac{\text{Working strain} \times \text{feet per min.}}{33{,}000} = \text{H. P.}$$

To find H.P. at any other speed up to 1000 feet per minute, proceed thus: Find H.P. in table for chain at 500 feet. Then multiply this H P. by speed required and divide result by 500. Example: Required H.P. of chain M. O. No. 124 at 700 feet. Capacity of No. 124 M. O. chain at 500 = 60 H.P. Then

$$60 \times 700 \div 500 = 84 \text{ H P. at 700 feet.}$$

catalogues and the questions of friction and jar take considerable of the strain given as safe. So whenever it has been my good fortune to use these chains I have watched them and made notes on the percentage to be deducted for ordinary service and friction. For example, take a case recently noticed: The chain was link belt No. 114, and, according to the table, it should be good to transmit a steady load of 15 horse-power at 250 feet per minute; it actually transmitted 14¼ horse-power at this speed with ordinary care. It broke at a strain transmitting 19¾ horsepower, so that this table is about correct with a deduction of say 5 per cent for friction when everything is new and in A1 condition.

Valley Park, Mo. W. O. Renkin.

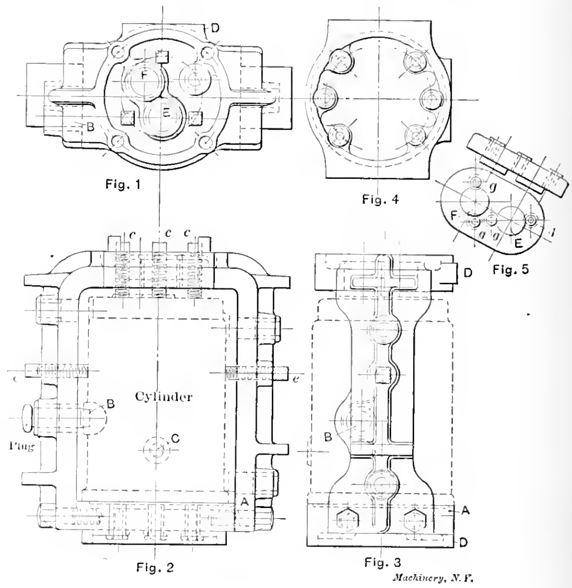
A GAS ENGINE CYLINDER JIG.

A. J. Brutsche.

Editor Machinery:

Figs. 1 to 5 show a jig used to bore, drill and tap a 2½ H. P. vertical gas engine cylinder. The jig must be strongly made with ribs and plenty of metal used throughout, to work successfully with this method of holding the cylinder. The first jig designed had neither the ribs nor the strength of this one, but as I thought was plenty strong enough. I soon saw my mistake, for at the first trial, in tightening the setscrews, *e*, the sides bulged slightly, and the same occurred with the upper setscrews. This last jig, however, overcame the difficulties caused by springing.

After the cylinder has been bored and faced it is placed in the jig with a dowel fit at *A* (the cylinder is shown dotted in Figs. 2 and 3). The tapered plug shown in Fig. 2 is driven into the cored exhaust port, *B*, the setscrews on the top and side are tightened, the plug slipped out, and the cylinder is



Jig for Drilling Gas Engine Cylinder.

ready for drilling. The plug referred to above is to locate and center the cylinder, for all the rest of the drilling is based on this exhaust port. This port, then, is the first to be drilled, after which the rest of the drilling is done as the jig is turned from side to side. After all the holes have been drilled the steel bushes are slipped out and the holes tapped. The tapped hole for the oiler at *C* has no bushing or guide, for it is only important to tap in the center of the boss, but the hole will always be at right angles with the ones on the side, because the jig rests on the legs, *D*. Fig. 4 shows the bottom of the jig, and the bushings for boring the bolt holes in the bottom of the cylinder. When the tapping is completed the setscrews are loosened and the cylinder taken out. The part of jig shown at Fig. 5 is then placed in the finished parts, *E* and *F*,

in the proper position, and the bolt holes, g, are drilled and tapped. This completes the cylinder, with all the holes parallel or at right angles to each other. A. J. BRUTSCHE.

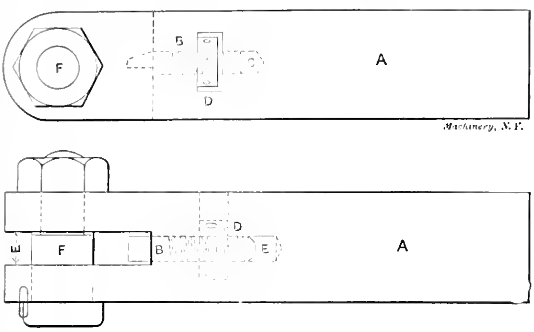
Dayton, Ohio.

A CUTTER HOLDER FOR SLOTTER.

Editor MACHINERY:

When a new concern is building its first machine for the market many schemes have to be resorted to; it is of one of these schemes I write. An involute gear was needed and it was decided to cut it on the slotter. Several forming tools were made and were not very satisfactory, principally on account of the poor quality of steel from which they were made. Then the plan here illustrated was tried and found to work finely.

A holder was made as shown in two views in the cut, into which was inserted a B. & S. involute cutter of the ordinary



A Holder for using Gear Cutters in the Slotter.

type used on a gear cutter for roughing out, and another holder was made for the finishing cutter. The body, A, of the holder is a forging planed to fit the toolholder, on the slotter. The pin, B, is of machinery steel, threaded. The hole, C, is drilled so as to provide clearance for the pin B. The pin B, on being screwed down, acts as a stop to bring the cutter tooth which is to do the cutting into the correct position. As soon as one tooth became dull the pin B was raised and another tooth was turned into cutting position, and the pin lowered as before. The cutter to be used for roughing having an even number of teeth the pin was placed centrally. For the finishing cutter holder, however, the pin B had to be placed at an angle, the finishing cutter having an uneven number of teeth. The nut D, which operates the pin B, works in a slot cut through the holder A. The nut has ¼-inch holes for a key or spanner wrench. E is the slot for the cutter and F is the clamping bolt.

The above device was used and worked satisfactorily. The cuts taken were not of the heaviest, of course, but the gear when cut ran quite smoothly, that being the result in mind.

Ridgway, Pa. G. E. WHITE.

A DANGEROUS BOILER.

Editor MACHINERY:

The recent disaster on board the United States gunboat *Bennington* reminds me of a case of neglected boiler sheets that happily did not result in a parallel disaster, but which for that reason alone seems most remarkable. The mill out of which the boiler was taken was located in New York City in a thickly populated district where, if the boiler had blown up, great loss of life would in all probability have resulted. When the weak condition of the boiler was discovered, it was immediately taken out, and as it was worthless for anything but scrap it was cut to pieces on the spot, in order to transfer it more conveniently. Walking down Bethune Street one day where the mill was located I was surprised at the light blows that were required to drive a cutting tool through the iron by a workman using a light sledge. Crossing the street I was amazed to find that for nearly the entire length of the boiler there was a thin place about 8 inches wide which in thickness was not more than 1-32 of an inch. The thickness gradually increased on each side until it reached the full thickness of the sheet. I was still more astonished when the foreman of the mill told me that two days before the boiler was taken out it was running with a steam pressure of 60 pounds per square inch, and that a week prior the boiler had been tested with a hydrostatic pressure of 90 pounds per square inch, and that it showed no leak or sign of weakness discoverable. The boiler was about 30 feet long and the thin part extended nearly the entire length. In some places where the chisel had been driven through I took hold of the thin metal with my fingers and tore off pieces, and when we consider that this thin sheet had stood a water test of 90 pounds per square inch, it seems little short of miraculous. Two days before the boiler was taken out was the regular cleaning day and one of the men inside the boiler thought that the sheet sounded very thin. He struck it a light blow with a scaling hammer and the head penetrated the sheet and in several places he repeated this astounding feat. Upon reporting the dangerous condition of the boiler it was at once decided to take it out and in the process of dismantling it was found that the brick wall in which the boiler was set was built up against a bank in the cellar under the mill and that the bank was wet and springy. Water flowed in tiny streams along on top of the wall, and a gutter had been hollowed out in the bank to lead the water off, but it appears that enough had found its way through to corrode the exterior of the boiler and produce the condition described. Of course it is not wonderful that the corrosion of the plates described took place, but it is very strange that they should have stood a pressure of 90 pounds without rupture.

Syracuse, N. Y. C. E. MINK.

[Our correspondent does not state the diameter of the boiler, but it probably was one of the small diameter type that was largely used forty or fifty years ago, and its small diameter is what in all probability saved an explosion. It is the thickness of the sheet relative to the diameter that determines the factor of safety. For example, a sheet 1 inch thick would be an absurdity for a boiler shell 60 inches in diameter, carrying 100 pounds per square inch, but for a boiler of the Scotch marine type, say 10 feet diameter, it is none too much. Supposing that the boiler described by Mr. Mink was 20 inches diameter, it follows that the bursting stress at 90 pounds per square inch would be $\frac{20 \times 90}{2} = 900$ pounds per lineal inch of the sheet. A good quality of iron having a tensile strength of 40,000 pounds per square inch might stand this pressure, even if only 1-32 of an inch thick, because it is not probable that the reduction in thickness was uniform. It is not to be denied that the condition discovered was extremely dangerous, but the point to be made is, although seemingly miraculous that the accident did not occur, it can probably be explained on entirely practical grounds, and conversely there will invariably be found some good and sufficient reason for the so-called "mysterious" boiler explosions of which we hear so frequently. —EDITOR.]

* * *

The recovery of gold from sea water promises to be one of the *ignis fatuii* which inventors pursue with an ardor worthy of a better cause. The amount of gold in sea water is very small, averaging about one grain per ton. Of course if this could be extracted it would mean that almost unlimited quantities of gold could be added to the world's store for there are millions of cubic miles of sea water to draw upon. To show the impracticability of such extraction, a paper was presented by Mr. G. F. Beilby before the British Association for the Advancement of Science. Mr. Beilby showed that in the working of gold mines cyanide liquors are allowed to run to waste containing as much as 100 grains or more of gold per ton because with all the efforts of highly-trained chemists it has not been found profitable to extract it any closer. And slimes containing eighteen grains or so when run through zinc precipitating boxes still contain 1½ grains per ton, or fifty per cent more than sea water. That there is a possibility of refining the process of extraction to such a degree that we will be able eventually to draw on the inexhaustible source of gold found in the ocean no one can deny but it will have to be of a nature quite different from anything now known, for the mere cost of pumping water through any extraction apparatus would eat up most, if not all, of the returns.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

IMITATION GROUND GLASS.

To make ordinary glass in windows or the camera appear as ground glass take a lump of glazier's putty and dab the surface of the glass with it. The result will be a good imitation of the real article. WM. NEWTON.

Oneonta, N. Y.

TO PREVENT BLANKING DIES FROM EXCESSIVE WARPING IN HARDENING.

After the die blank is cut from the bar, machine all over, then heat to a cherry red and allow the same to cool. When cool, machine to finish size, and work out in the usual way. Pack harden the die and dip in a solution of one-third oil and two-thirds water. C. F. EMERSON.

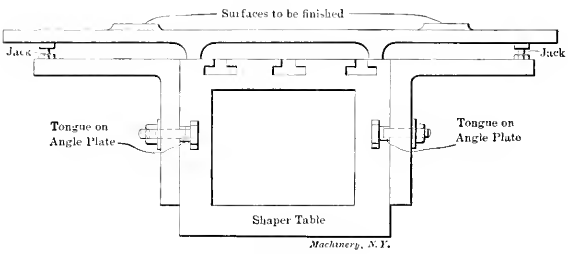
TO SOLDER BRASS OR STEEL TO STEEL.

To secure a permanent joint when soldering brass to steel or steel to steel, after polishing both surfaces, coat with your coppering solution (blue-vitriol and water), then apply the acid and apply the solder. This mode of treating the surface to be soldered is particularly valuable when filling in metal patterns or adhering a small piece to a large one.

Rochester, N. Y. CARROLL ASHLEY.

ANGLE PLATES TO EXTEND SHAPER TABLE.

Very often we get a job that is too long to be properly supported on the shaper table, and not having a planer we find it effective to bolt angle plates on either side of the shaper table

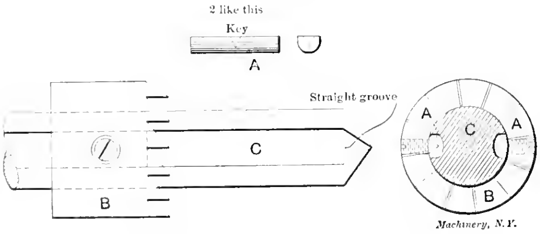


and use jacks in the usual manner. The cut shows the idea sufficiently well, so no further description is necessary.

Chicago, Ill. ROBERT A. LACHMANN.

COMBINATION DRILL AND COUNTERBORE OR FACING TOOL.

The straight-lip drill called the "Farmer" drill has its advantages, one of which is the drilling of brass, there being no need to grind off the cutting edges (as is the case with the twist drill) to prevent catching in the work. Where it is desirable to drill and counterbore or face at one operation, I find the Farmer drill excellent, for the simple reason that its straight flutes make a good driving medium; that is to say, they can be made to act as keyways very nicely. While I



admit that for steel, and even cast iron (especially for long drilling), the twist drill acts best, owing to the angle of the cutting edges, yet it is also true that for short holes the straight-lip drills act O. K. The form of key used is shown at *A*. *B* is the counterbore or facing cutter, and *C* is a Farmer drill. The combination tool will be found especially valuable in light manufacturing, but, of course, is also very handy for the general run of work. ROBERT A. LACHMANN.

Chicago, Ill.

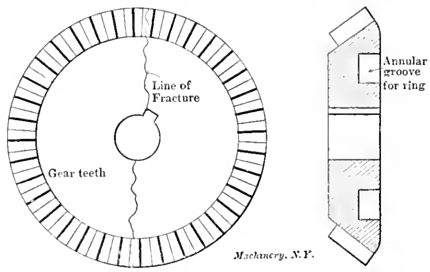
BICYCLE TIRE ANTI-LEAK.

The solid or some form of cushion tire is considerably used now by mechanics and others who ride their bicycles to and from the shop, in preference to the pneumatic tire because of its durability and freedom from puncture. But pneumatic tires can be made reliable and quite safe from punctures by using a liberal amount of the following cheap mixture: 1 pound of sheet glue dissolved in hot water in the usual manner, and 3 pints of molasses. This mixture injected into the tire through the valve stem semi-hardens into an elastic jelly, being, in fact, about the same as the well-known ink roller composition used for the rollers of printing presses. This treatment will usually be found to effectually stop leaks in punctured or porous tires. F. EMERSON.

Newark, N. J.

REPAIR OF A BROKEN BEVEL GEAR.

Some time ago I had a repair job on one of our machines, a bevel gear being broken as shown in the sketch. A new gear would cost about $2.75, and getting it would mean a delay of about a week. I put the broken parts of the gear together and caught it in a lathe chuck with the back of the gear out.



An annular groove was turned in the back, and then a steel ring was turned up to fit. When the ring was pressed into place the gear was stronger than when new. By this simple kink we saved $2.50 and a week's delay.

Cincinnati, Ohio. JOHN ASPENLEITER.

Someone has written: "A little drop of oil, a little bit of care; saves a lot of toil, avoids a lot of wear," which although it barely escapes being a platitude, is nevertheless worth remembering, especially with machines designed in the old way. The modern method of designing machinery, however, should be that of making each bearing self-lubricating so far as possible. The idea that all machines must necessarily require a lot of personal attention in the matter of oiling every bearing is nonsensical. There is no more reason why each bearing on high grade machinery, at least, should require personal attention than that a footbridge should be built without railings. Let the machine tend to its own lubrication and we make it much more efficient and durable. The constant need of attention to lubrication becomes a drudgery and is a waste of useful effort which might better be employed in increasing the output.

* * *

The reporter of a daily newspaper is generally a hard-worked man who is often asked to do the impossible, that is, make intelligent reports about things of which he knows little or nothing. It is not strange, therefore, that he sometimes "falls down" badly, when writing on things mechanical. Owing to a mix-up of some steers with a locomotive on the Lackawana recently, a freight train was derailed and part of an important shipment of the Crocker-Wheeler Co. was thrown about somewhat promiscuously. A local reporter visited the scene and seeing that halves of a large generator were displaced so that the planed surface of the joint was visible, he at once jumped to the conclusion that the frame was broken, and so reported. To his untrained eye the difference between a machined surface and a fracture was not apparent.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

110. TO RESTORE BURNT STEEL.

To restore burnt cast steel heat the piece to a red heat and sprinkle over it a mixture of 8 parts, red chromate of potassium; 4 parts, saltpeter; ¼ part, aloes; ¼ part, gum arabic; and ¼ part, resin. A. A.

111. USE OF TURPENTINE FOR WOUNDS.

The machinist often cuts or bruises his hands and by having a small bottle of turpentine handy he can at once bathe the injured part, which will relieve the soreness and perhaps protect from blood poisoning. F. H. JACKSON.
Angelica, N. Y.

112. CEMENT FOR CAST IRON.

To make a cement for cast iron take 16 ounces cast-iron borings; 2 ounces, sal-ammoniac; and 1 ounce, sulphur. Mix well and keep dry. When ready to use take one part of this powder to 20 parts of cast iron borings and mix thoroughly into a stiff paste, adding a little water. A. A.

113. MIXTURE FOR MAKING PLUG COCKS TIGHT-SAME FOR GLASS STOPPERS.

To make an anti-leak and lubricating mixture for plug cocks use 2 parts of tried suet and 1 part of beeswax melted together; stir thoroughly, strain and cool.

A mixture for making glass stoppers tight is made by melting together equal parts of glycerine and paraffin.
Worcester, Mass. L. S. BURBANK.

114. TO PREVENT HANDS CHAPPING IN WINTER.

The winter season is now starting in and a machinist's hands are apt to get sore and stiff from exposure. Take a four-ounce bottle and put in same 3 ounces glycerine, 1 ounce alcohol, and from 20 to 30 drops of carbolic acid. After washing the hands, and while they are a little damp, apply a few drops and thoroughly rub it in. A good time also to use it is at night. F. H. JACKSON.
Angelica, N. Y.

115. LIQUID COURT PLASTER.

At your druggist's procure an ounce bottle and have him fill it three-fourths full of flexible collodion, and fill up with ether. Apply to cuts, bruises, etc., and it protects them and will not wash off. If the ether evaporates, leaving it too thick for use, have more ether put in to liquefy it. It is a good thing to have in the house; also the tool chest.
Angelica, N. Y. F. H. JACKSON.

116. ACID TEST FOR IRON AND STEEL.

A simple acid test for iron and steel is made as follows: The sample to be tested should be filed smooth or polished. Then place it in dilute nitric or sulphuric acid for from 15 to 20 hours; then wash and dry the sample. The best steel then has a frosty appearance; ordinary steel has a honeycombed appearance; and iron presents a fibrous structure in the direction in which it has been worked. A. A.

117. RUST PREVENTIVE FOR TOOLS.

The following I have used for a number of years, and found it O. K. in every respect. Take a pound of vaseline and melt with it 2 ounces of blue ointment—what druggists call one-third—and add, to give it a pleasant odor, a few drops of oil of wintergreen, cinnamon, or sassafras. When thoroughly mixed pour into a tin can—an old baking powder can will do. Keep a rag saturated with the preventive to wipe tools that are liable to rust. F. H. JACKSON.
Angelica, N. Y.

118. WATER- AND OIL-PROOF CEMENT.

Some time ago I built a gasoline engine and boat, but when I put the rig on the river I found the engine would run for a short while and then stop. I found that the cause was some sand holes in the cylinder which admitted water into the bore of the cylinder. To stop the holes I used litharge and glycerine mixed to a stiff paste. The cement soon got as hard as iron and I had no further trouble from leakage. I found that this cement is better than anything else I have ever tried.
Dayton, Ky. ALBERT ELMIGER.

119. ETCHING FLUID.

I have found the following receipt for a fluid for etching steel to be very satisfactory, both for frosting effect and deep etching. Mix 1 ounce sulphate of copper, ¼ ounce alum, ½ teaspoonful of salt (reduced to powder), with 1 gill of vinegar and 20 drops of nitric acid. This fluid can be used either for etching deeply or for frosting, according to the time it is allowed to act. The parts of the work which are not to be etched should be protected with beeswax or some similar substance. S. C.

120. STEEL WELDING COMPOUND.

A good compound for welding cast steel is made as follows: 41½ parts, boracic acid; 35 parts, common salt; 20 parts, ferrocyanide of potassium; 7½ parts, resin; 4 parts, carbonate of sodium. Heat the pieces to be welded to a light red heat and apply above compound, then heat to a strong yellow heat and the welding may be accomplished in the usual manner. A. A.

[The usual precaution applies, of course, in the use of the above, the same as with any of the cyanides, and that is to avoid breathing the poisonous fumes.—EDITOR.]

121. CEMENT FOR ATTACHING SOFT RUBBER TO IRON OR OTHER METALS.

A cement which is effective for cementing rubber to iron and which is specially valuable for fastening rubber bands to band-saw wheels is made as follows: Powdered shellac, 1 part; strong water of ammonia, 10 parts. Put the shellac in the ammonia water and set it away in a tightly closed jar for three or four weeks. In that time the mixture will become a perfectly liquid transparent mass and is then ready for use. When applied to rubber the ammonia softens it, but it quickly evaporates, leaving the rubber in the same condition as before. The shellac clings to the iron and thus forms a firm bond between the iron and the rubber. M. E. CANEK.
Altay, N. Y.

122. LUBRICANTS FOR REDRAWING SHELLS.

Zinc shells should be clean and free from all grit and should be immersed in boiling hot soap water. They must be redrawn while *hot* to get the best results. On some shells hot oil is sometimes used in preference to soap water.

For redrawing aluminum shells use a cheap grade of vaseline. It may not be amiss to add that the draw part of the redrawing die should not be made too long, so as to prevent "too much friction," which causes the shells to split and shrivel up.

For redrawing copper shells use good thick soap water as a lubricant. The soap used should be of a kind that will produce plenty of "slip"; if none such is to be had, mix a quantity of lard oil with the soap water on hand and boil the two together. Sprinkling graphite over the shells just before redrawing sometimes helps out on a mean job.

C. F. EMERSON.

* * *

It would appear that the rosy prospects for enormous power development at Victoria Falls at South Africa, have been somewhat overestimated, if we are to believe what Prof. Ayrton says regarding the dependable power of this great cataract. It appears that the volume of water falling over the falls is a greatly variable quantity, whereas that of Niagara is very constant. At the periods of minimum flow Prof. Ayrton estimated that the available power of the Victoria Falls is only about one-tenth that of Niagara, where we have been lead to believe that it was over four times as great. Prof. Ayrton thinks the prospects for profitable transmission of power from the Victoria Falls to Johannesburg are very doubtful. In November, at the period of minimum flow, the available power from the falls is as low as 300,000 horse power, if the whole volume of water is utilized.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

3. D. C. T.—I would like to see formula for red and white writing solutions for blue prints. Something that will not spread on prints as ink does on blotting paper.

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4. R. K.—Will you kindly give me some information through your columns regarding the welding of steel on the iron backs of shear blades and whether the shear back is made from the bar or by some other process?

5.—Draftsman.—I have a celluloid protractor which causes me considerable trouble by warping so that it does not lie flat on the drawing board. Is there any remedy for this?

A.—We referred this question to the Whitehead & Hoag Co., Newark, N. J., manufacturers of celluloid specialties. They replied as follows: Warping and curling of celluloid articles like protractors cannot be prevented in the manufacture. We have found it very difficult to prevent this under certain climatic conditions, as, for example, when there is a sudden change in weather. Warm weather especially affects the celluloid. In case of warping or curling, however, your inquirer will find that by laying a piece of heavy paper over the article and using a hot iron he can press it into shape.

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6. C. E. G.—A number of subscribers would be pleased if you would explain why data sheet No. 48 was made an odd size, so that it is impossible to fold it with the other sheets. From time to time we have seen articles in MACHINERY and various other mechanical papers explaining the advantage of having catalogues, data sheets, and other information of a uniform size. Now, in the face of all this you issue a data sheet which it is impossible to fold with anything.

A.—The reason data sheet No. 48 was made an odd size was because the material that it contained was of such a nature that it was impossible to arrange it upon standard 6 x 9 sheets. It was therefore a case of either withholding this sheet from our readers or else of giving them the valuable formulas that it contained on an odd size sheet. We chose the latter course.

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7. V. V. W.—Must a dynamotor, or motor generator, be used to charge storage batteries? If so why? I wish to get a ¼ horse power motor to run a small lathe, the motor to be run by storage batteries, what voltage would require the least number of batteries to run the motor? How many cells would be required to run the motor at 110 volts? Could the motor be used as a dynamo to recharge the batteries?

A.—It is not necessary to use a motor generator to charge storage batteries, any source of continuous electric current can be used if the voltage is high enough. To charge one cell, or any number connected in parallel will require an e. m. f. of about 3 volts. If the cells are connected in series, the e. m. f. of the charging current should be at the rate of not less than 2.2 volts per cell. The amperes of current required to charge the cells will depend upon their capacity. If the current is small it will require a long time to charge. Too strong a current cannot be used, however, without injury to the cells. This is also true of the discharging current. Information as to the proper current for charging and discharging can be obtained from the makers of the battery. b. The smallest number of cells that could be used to run the motor mentioned is one, but in that case the motor would have to wound for an e. m. f. of 2 volts, which would make the armature wire entirely too large for so small a machine. The best number of cells would be about 10, connected in series, so as to give a voltage of 20. Any of the storage battery manufacturers will give you data as to the size of cells for such a case. To operate a 110-volt motor would require about 60 cells connected in series, but each cell would be of very small size. The battery can be recharged with the motor, but the speed of the latter would have to be considerably higher than that at which it runs as a motor.

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8. J. I. S.—I note with interest the question of J. S. S. in the August issue on hardening 6-inch milling cutters and the answer thereto by Mr. E. R. Markham. Why does Mr. Markham advise taking the cutter out of the warm oil and holding it over the fire? With such treatment I should expect that a cutter of this size would break as the thin edges would expand much more rapidly than the body. Why not leave the cutter in the oil until it is cooled down, and then start a fire under the oil and draw the cutter to the desired temper?

Answered by E. R. Markham, Cambridge, Mass.

A.—When a piece of steel is hardened internal strains are set up by the unequal contraction; some parts of the metal try to go in one direction and others in another. Sometimes the stresses are not sufficiently great to manifest themselves, but again they may cause the hardened piece to break some hours or even days after the piece has hardened. It is a well-known fact that a bar of hardened steel may be sprung if it is heated somewhat, and mechanics often take advantage of this fact to straighten reamers, counterbars, etc., that have sprung in hardening. Now, if a piece of hardened steel is taken from the bath and immediately placed over the fire and the outside is heated to a temperature of 300 to 400 degrees F. this portion becomes somewhat yielding and as a consequence the exterior will conform to the interior stresses without breaking or cracking. Of course the operator must not heat the piece so rapidly as to suddenly expand the small projections, but must do it slowly. Every mechanic who has occasion to harden large pieces of steel knows the danger of not removing internal strains. Very small pieces do not have these internal strains to any extent, but pieces of large size must be reheated in order to give internal stresses an opportunity to adjust themselves.

* * *

DEPTHS OF U. S. STANDARD AND "V" THREADS

Most screw tables in common use do not give the depth of a thread directly, it having to be found by subtracting the root diameter from the outside diameter and dividing the remainder by 2. Thus to find the depth of thread on a U. S. standard 1-inch screw it would require subtracting 0.8376

DEPTHS OF UNITED STATES STANDARD AND V THREADS.

Threads per inch.	Double Depth U. S. S.	Depth U. S. S.	Double Depth V Thread.	Depth V Thread.
40	.0324	.0162	.0433	.0216
36	.0360	.0180	.0481	.0241
32	.0405	.0203	.0541	.0271
30	.0433	.0216	.0577	.0289
28	.0463	.0232	.0618	.0309
26	.0499	.0250	.0666	.0333
24	.0541	.0271	.0721	.0361
22	.0590	.0295	.0787	.0394
20	.0649	.0325	.0866	.0433
18	.0721	.0361	.0962	.0481
16	.0811	.0405	.1082	.0541
14	.0927	.0464	.1235	.0618
13	.0999	.0499	.1332	.0666
12	.1082	.0541	.1443	.0722
11	.1180	.0590	.1574	.0787
10	.1299	.0649	.1732	.0866
9	.1443	.0722	.1924	.0962
8	.1623	.0812	.2165	.1082
7	.1855	.0928	.2474	.1237
6	.2165	.1082	.2886	.1443
5½	.2361	.1181	.3149	.1574
5	.2598	.1299	.3465	.1732
4½	.2886	1443	.3848	.1924
4	.3247	.1624	.4330	.2165
3½	.3711	.1856	.4948	.2474
3	.4333	.2166	.5773	.2887

from 1.0000 and dividing the remainder, 0.1625 by 2, which operation gives 0.0812 as the depth of the thread. Mr. Edward R. Barker, of Worcester, Mass, has contributed the above table, which gives the difference between the root and outside diameters directly, and we have extended it so as to give the depth of a thread directly.

* * *

The fact that white mice are abnormally sensitive to gasoline vapor makes them valuable as detectors of gasoline leaks on submarine boats. The *Youth's Companion* says that the moment the air becomes contaminated with the slightest odor of gasoline the mice will begin to squeak and show general signs of discomfort. For this reason they are, it is alleged, used by the British Government on all submarine boats and each boat is allowed a shilling a week for their maintenance.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

THE BULLARD "RAPID PRODUCTION" BORING MILL.

The increasing use of high speed steels has introduced changes in the design of machine tools in more than one direction. Not only has it made necessary the use of larger bearing surfaces, stiffer design and a more liberal distribution of cast iron, but it has also called attention to the advantage of furnishing the workman with every facility for handling the work, and making the necessary changes in speed and feed adjustments and setting of cutting tools on the machines. Suppose that in doing a certain piece of work the actual time

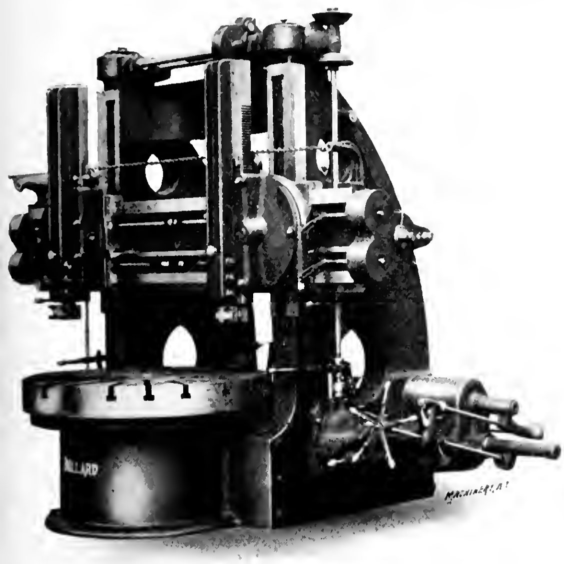


Fig. 1. Front View of Boring Mill.

spent in cutting is three hours, while the time expended in setting up the work and making various adjustments is one hour; twenty-five per cent of the time is then lost. If, as is entirely within the bounds of possibility, improvement in the design of the machine and the use of a tool steel of greater capacity should reduce this cutting time to one and a half hours, while the time for setting up, etc., still remains at one hour, the waste time would be increased to forty per cent; thus the improvement which increases the ability of a machine tool to take heavy cuts also makes the providing of facilities for handling the machine easily and rapidly a matter of great moment. The Bullard Machine Tool Co. of Bridgeport, Conn., have recently built a boring mill in which, for the reasons outlined above, special attention has been paid to this matter. The half-tones and accompanying description will explain those features of the machine which bear on this point.

Figs. 1 and 3 are front and rear views respectively of a fifty-four-inch boring mill. Starting first with the drive to get a general idea of the arrangement of the machine, power is furnished in the case illustrated by a motor mounted in a cradle set between the housings at the rear of the machine. This motor, which is run at a constant speed, is belted to the driving shaft below it, from which the motion is transmitted by gearing to speed box *A* seen in Fig. 2. A double cone of gears at this point provides for five speed ratios. From here a horizontal shaft transmits motion to the enclosed headstock mechanism, consisting of a system of gears and positive clutches operated by means to be afterward described. This allows a further choice of three ratios, thus giving a total of fifteen speeds to the table from a single speed motor.

Fig. 2 shows very clearly the arrangement of the operating handles of the machine. This arrangement has been made on what the builders call the "automobile principle." If the reader has a vivid imagination perhaps he may descry the location of the steering wheel, spark controller, throttle, speed change and reverse levers, and other accessories of the controlling mechanism of the horseless carriage. The phrase of course implies that the handles are all within easy reach of the operator in just the same way that the controlling mechanism of the automobile is within easy reach of the chauffeur. In Fig. 2, starting with the arrangement for changing the speed of the table, pilot wheel *B* operates the mechanism in speed box *A*, giving five changes. By lifting handle *C*, which projects from the center of this pilot wheel, a brake may be applied to the table, stopping it instantly at any desired point. Disk *D* interlocks the shaft above it in such a way as to make it impossible to operate this brake unless the gears in the speed box are disengaged from the spindle driving mechanism. Handle *E* may be given three positions to correspond with the three changes of speed obtainable in the headstock. Disk *D* again interlocks with this handle and the shaft on which it is mounted, making it impossible to change the positive clutches in the head stock except when the table is stopped and the brake set. It would thus seem to be impossible for the workman to seriously damage the machine, no matter how evilly disposed he might be.

Handle *F* operates a feed box mechanism similar to that commonly employed on lathes. Handles *G* and *F* together make a total of ten changes obtainable from the five gears in the cone of the feed box. The feed is reversed at *H*. From the feed box a vertical shaft transmits the motion to the gearing at the end of the cross rail. Through lever *J*, which operates a pair of friction clutches, the feed motion is applied either to the movement of the head on the cross rail or to the vertical feed of the ram. The friction clutches operate as a safety device, protecting the rest of the machine if for any

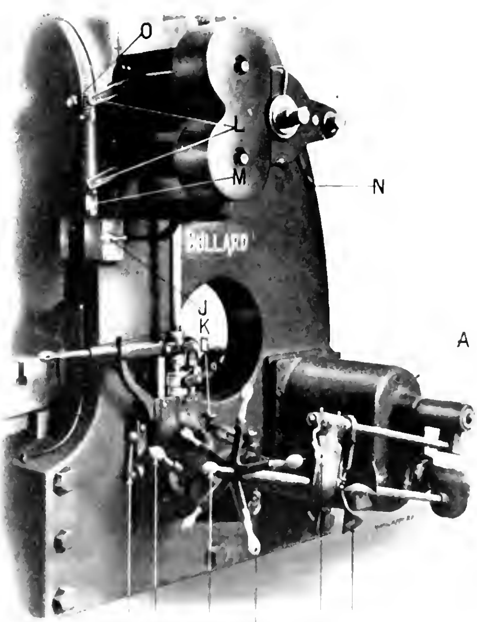


Fig. 2. Arrangement of Controlling Handles

reason the heads are run together or the motion of the slides is blocked. Lever *K* provides for the rapid traverse of the tools, as may be seen more clearly in Figs. 1 and 3. The vertical shaft carries at its upper end a pair of friction cones which may be brought in contact with a similar cone on a high speed shaft extending across the top of the housings. The ram will be moved up or down, or the head will be moved in or

out, depending on the position of lever J, and on whether lever K is moved up and down. When this latter handle is in its central position the friction cones are disengaged and the feed mechanism is in gear. When either of the friction cones is engaged the feed from the feed-box is disengaged. The advantage of making the feed reverse in the feed-box at H will be appreciated by the workman, since the direction of the rapid traverse of the tool always bears a fixed relation to the movement given lever K. This is not the case in the usual design, where the change in direction of feed is made at the end of the cross rail.

The entire absence of hand wheels, cranks and slip gears will be noticed. Of course a fine hand adjustment is necessary for the accurate setting of tools. Provision is made for this on the traversing screw and the rack feed shaft by mounting on each of them an automatic friction grip L. Ordinarily the screw and shaft are free to rotate within the hubs of these levers, but when they are grasped by the hand of the workman they tighten on the screw or shaft and furnish a means for making minute adjustments. So far as the change of the spindle speeds, the handling of the table, and the movements of the right-hand head are concerned, everything may be done by the operator without stirring from his tracks. The feed mechanism, however, is duplicated on the other side of the machine for the left-hand head, since the operator would naturally stand on that side when adjusting the tools for that head.

The bearing of the head on the cross rail is designed in such a fashion as to allow the least possible amount of lost

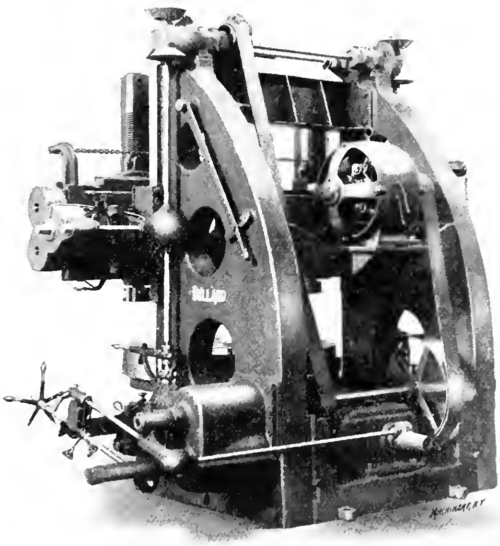


Fig. 3. Rear View showing Driving Mechanism.

motion. The head is guided by a narrow bearing at the lower end of the crossrail as may be seen from the front view in Fig. 1. The screw which feeds it along the rail is placed in the center of this bearing as is also the center stop, thus avoiding the possibility of any canting or cramping. The bearing at the upper side of the rail does not act as a guide, but serves to prevent the top of the head from being swung forward by the pressure of the cut on the tool. The crossrail is guided by the face of the right-hand housing in a similar manner. In raising and lowering the rail by power, the motor is stopped and lever N moved either upward or downward, depending upon whether the operator wishes to raise or lower the rail. The motor is then started up and the elevating screws are revolved to bring the rail to the proper location. The shaft which runs across the top of the housings and drives the elevating screws through bevel gears is driven by a spur gear mounted on a quill. This quill is pinned to the shaft at its center, thus making the torsional deflection the same at each side and keeping the crossrail parallel whether it is being elevated or lowered.

In Fig. 4 is shown an attachment which may be used either for taper facing or thread cutting. By comparing it with the end of the crossrail, as shown in Fig. 1, it will be seen that change gears have been mounted on the ends of two of the projecting shafts, and a quadrant attached for carrying intermediate gears. By this means a thread of any desired pitch may be cut, or, by making a simple change in the mechanism, the down feed of the ram and the cross feed of the head may be engaged simultaneously, the one feed working at a predetermined ratio with the other. This allows the turning of angular surfaces which are beyond the range of the swivel head. To facilitate thread cutting, the quick return may be used in running the tool back between the cuts. For this pur-

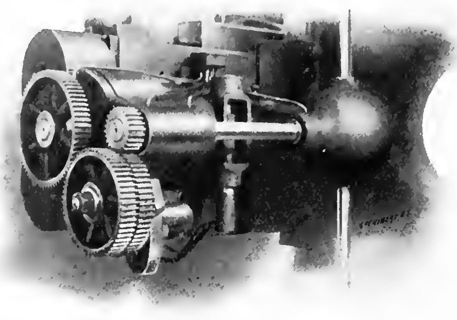


Fig. 4. Thread-cutting Attachment.

pose the clutch, controlled by quick traverse lever K, which connects the vertical feed rod with the feed gearing is made with one tooth, so that the position of the tool bears an unvarying relation to that of the work, no matter when or where the positive gearing may be thrown in. It is thus not necessary to reverse the table motion when cutting threads or scrolls.

As to the general construction of the machine, every care has been taken to make it durable and strong. The transmission gears run in oil. All the high speed shafts are ring oiling and are supported in bronze boxes. The table bearing is in the form of an approximation to the Schiele curve, and the provision for lubrication is such that the spindle runs in a bath of oil. The machine will handle work up to 56 inches in diameter and 42 inches in height. It occupies a total projected floor space of 92 x 124 inches.

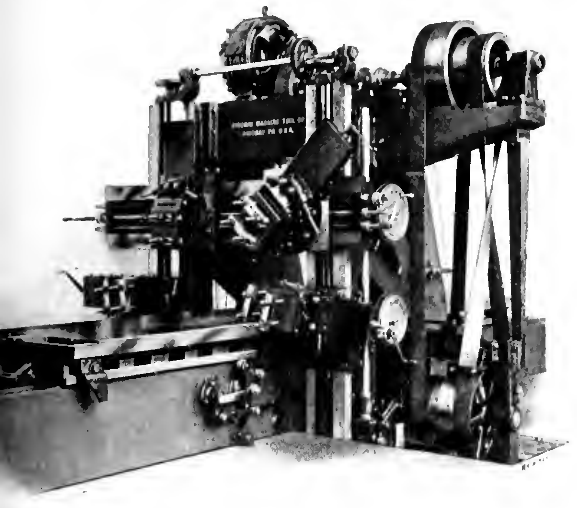
48-INCH x 48-INCH RIDGWAY PLANER.

"Massive construction" and "rigid design" are terms which appear with unvarying regularity in the descriptions of practically every new tool put on the market. Sometimes the use of these terms is justified, and sometimes perhaps it is not. The photograph of this Ridgway planer, of which a halftone reproduction is shown below, gives one the impression that the term is not misapplied in this case at least, since the designer appears to have been granted a free hand as to the amount of cast iron he was at liberty to use, and apparently it has been used to good advantage.

The side walls of the bed are tied together with heavy cross girts, reinforced by double walls at the gear space. It is twice the length of the table, thus avoiding any overhang. The table is made in such a way that no chips or dirt can drop between the ways. The standard design provides for T-slots and reamed holes, but any other arrangement will be furnished without extra charge. The table is of box form and unusually deep. The large openings on the sides permit the withdrawal of the chips which drop into the interior. The rack is 11 inches wide and of 2 diametral pitch and the gearing is of steel throughout.

The uprights are finished to receive side heads, whether they are ordered or not, so the heads can be attached at any subsequent time. The cross rail is made in box form and is long enough to allow the head to traverse the entire width of the planer. In addition to the gibs on the outside edge of the housing face, there are also clamps on the inside, so the

strain of the cut is not transmitted across the face of the upright, where the cross rail is weakest. The side heads will travel entirely below the table and may be swiveled to any angle like those on the cross rail. And adjustment for the feed along the cross rail is made at the end of the cross rail and for the side head on the head itself. By means of a notched plate any desired feed within its range may be instantly obtained while the planer is in motion on its shortest stroke. No feed boxes are used, the reciprocating motion for any operation being obtained from the running gearing by a patented device which gives the maximum amount of feed



48-inch x 48-inch Ridgway Planer.

required with about 3 inches of table movement. Wherever possible the bearings are made self-lubricating. In a shop test the machine required 35 horse-power to carry four cuts one inch deep and one-eighth feed in cast iron.

With the arrangement shown in the cut, the motive power is furnished by a Thompson-Ryan variable speed motor. The machine was built to meet the requirements of Mackintosh, Hemphill & Co., of Pittsburg, Pa., and it weighed 75,000 pounds. The Ridgway Machine Tool Co., Ridgway, Pa., are the builders.

A ONE-BELT REVERSING COUNTERSHAFT.

Fig. 1 shows an exterior view and Fig. 2 a sectional drawing of a recently designed countershaft. The idea of the inventors is to do away with one belt and from two to three pulleys in the driving of any machine which requires that the motion shall be reversed. As may be seen from the half-tone the shipper actuates a double-ended thimble on the countershaft. As this thimble is moved outward or inward from the central position, the outer clutch levers or the inner clutch levers are

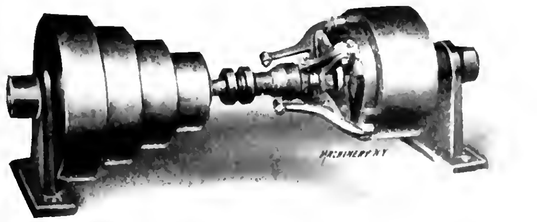


Fig. 1. One Belt Reversing Countershaft

spread apart, thereby tightening the clutch surfaces to which they are connected and driving the countershaft ahead or backward, as the case may be. Referring to the sectional view, Fig. 2, a belt from the main line drives pulley *A*. This revolves loosely on the sleeve, *B*, which forms a box for the countershaft in hanger, *C*. Screwed and doweled to the inside rim of pulley, *A*, is an internal gear, *D*. This engages the teeth of pinions, *E*, of which there are three, equally spaced, mounted on studs in disk, *F*, which is keyed to sleeve *B*. Flange, *G*, rotates loosely on the shaft, carrying with it gear *H*, which meshes with pinion *E*. The outside of this flange is formed into a gripping surface for the inner pair of clutch levers, *J*. To the outside of pulley *A* is fastened a plate, *K*, bearing another gripping surface for the outside pair of clutch levers. The parts on which these two pairs of gripping surfaces are formed will thus be seen to be driven in opposite directions by the gearing, the speed of one being about twice that of the other. As the double-ended thimble is moved either to the right or to the left the shaft is clutched to one or the other of these two surfaces and thus made to rotate forward, or at a higher speed backward. The mechanism is enclosed in an oil bath.

This device is the invention of H. W. Ricks and George W. Stifel of Cambridge City, Ind. The invention may also be adapted for use as a reversing mechanism for gasoline launches. Blue prints and other information will be furnished to interested parties on application, as the patent is for sale outright or will be leased on royalty.

KEARNEY & TRECKER MILLING MACHINE.

A heavy-duty milling machine, of new design throughout, and which is adapted either for motor or belt drive, has been placed on the market by Kearney & Trecker, Milwaukee, Wis. This machine is the largest of a series of three of similar type and is unusually massive. The variation in speeds and feeds is obtained entirely by gearing, enabling a constant speed motor to be used or in the case of belt drive, a single driving pulley is all that is required and the machine can be belted direct to a main line shaft without the intervention of a countershaft or cone pulleys.

A characteristic of this milling machine is that the motor attachment can be made without resorting to any makeshift or any belt or chain connection between the motor and the machine. It will be noted that the pulley bracket interchanges with the motor and that the latter is standard with the exception of the head, which is made special, so that it can be bolted to the frame of the machine in place of the

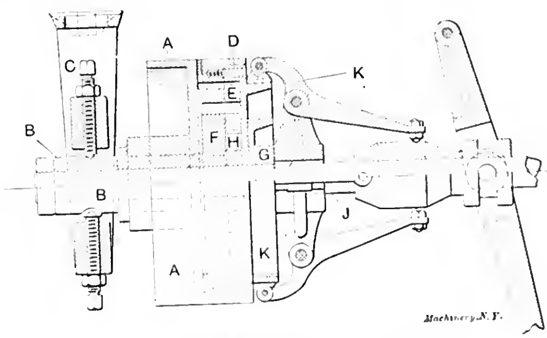


Fig. 2. Section through Gearing and Clutch Mechanism.

pulley bracket. When the motor is attached it is virtually a part of the machine, and looks as though it were a part of it, instead of an attachment. This type of motor drive has one advantage over special designs to suit the variable speed motors in that nothing special is required to convert the machine from a belt drive to a motor drive, or vice versa.

Another characteristic of the machine is the fact that it is entirely self oiling. The driving mechanism, the feed change gearing, and all bearings, including the spindle bearings, are oiled by means of a pump in connection with an oil reservoir in the base of the machine. This pump is a simple spur gear pump containing no valves to get out of order and it will supply a stream of oil so long as there is oil in the reservoir to feed it. Equally complete arrangements are provided for the lubrication of the cutters. Every machine, whether so ordered or not, is equipped with a pump and piping for lubricating the cutters and ample means for returning the lubricant to its reservoir in the base.

There are 18 spindle speeds provided, ranging from 13 to 320 revolutions a minute, or in this ratio, the exact speeds depending, of course, upon the speed of the driving shaft

The feed of the machine is taken from a constant speed shaft and provides a variation from ½ inch to 16 inches per minute.

Referring to Fig. 1, lever No. 1 is the starting and stopping lever. It engages a positive clutch with hardened teeth, which is used in preference to a friction clutch. Lever No. 2 has three positions and in connection with No. 3 which has six positions provides a geared drive with 18 changes of speed as stated above. Lever No. 3 is operated in connection with No. 4 which gives the connection below to the main driving shaft. The feed box is clearly shown in Fig. 3, there being two levers on top of the box and one at the end for giving the twelve changes in feed.

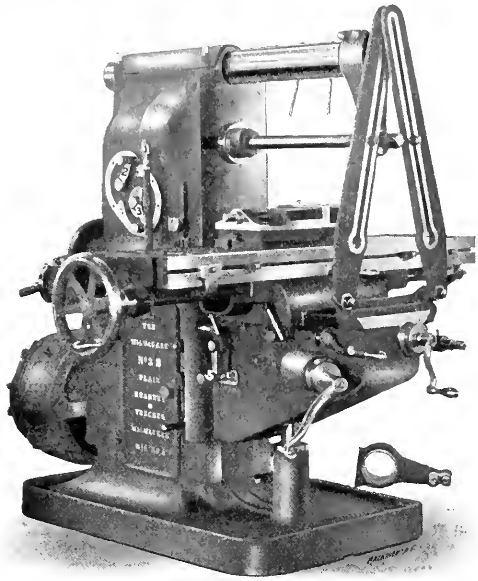


Fig. 1. Heavy Geared Drive Milwaukee Miller.

A locking lever 5 at the side of the knee in Fig. 1 is for positively locking out two feeds while the third one is being used; thus, when in the centered position, as photographed, only the table feed can be engaged, it being impossible to move lever 6 which engages and disengages the cross and vertical feeds.

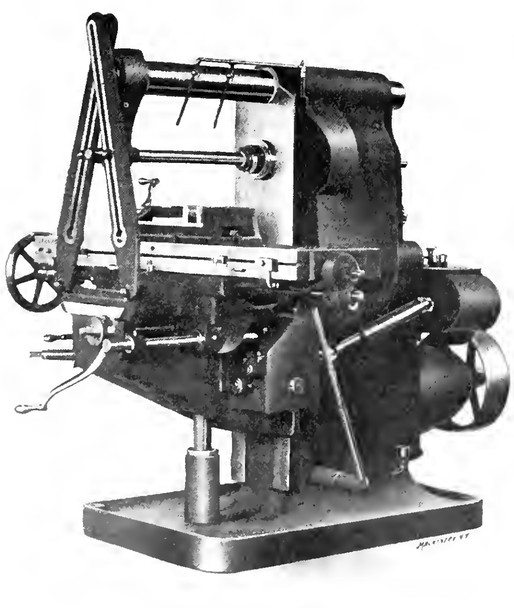


Fig. 2. Side View showing Feed Connections.

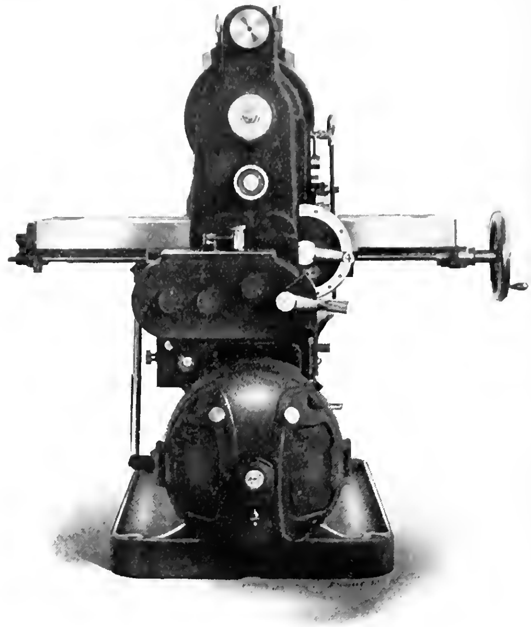


Fig. 3. Rear View.

The oil reservoir for lubricating the working parts is in the base of the column and is filled through the funnel shown near the bottom of the column in Fig. 2. The reservoir for the cutting lubricant is located in the closet of the machine from which it is forced to the flexible pipe that delivers it to the cutter. The table has a deep oil channel around its outer edge and screens which separate the chips from the oil, after which the oil flows to the saddle and down through the telescopic tubing (Fig. 2) and into the reservoir.

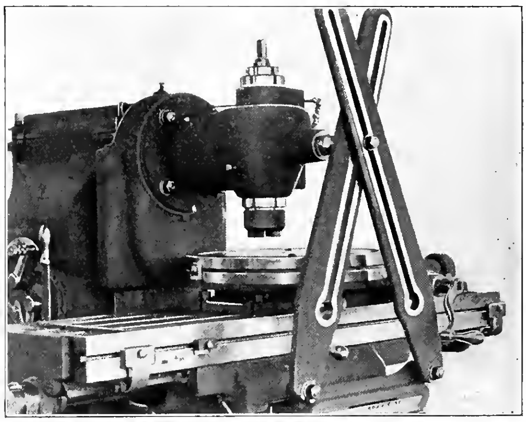


Fig 4. Vertical Milling Attachment.

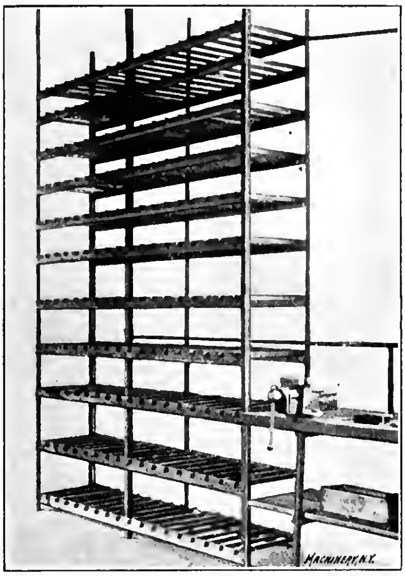
The machine may be equipped, if desired, with the rotary table and a vertical milling attachment shown in Fig. 4. This attachment can be ordered and placed on the machine after it has left the factory if so desired, without any trouble on the part of the purchaser. It will be noted that the slide of the machine is carried to the top of the column and that the base of the vertical milling attachment fits over this slide and is clamped to it, making an unusually rigid construction.

In providing for the electric drive an overload release attachment is supplied which breaks the circuit and stops the motor when the power delivered exceeds 10 horse power, this being all that should be needed or expected on a machine of this size.

The table has a longitudinal feed of 3 feet, a cross feed of 12 inches, and a vertical feed of 20 inches. The working surface of the table is 14 x 55 inches and the total weight of the machine with the motor 5,000 pounds.

A METAL STOCK RACK.

The illustration below is reproduced from a photograph made of a new metal rack, which is built by F. E. Wells & Son Co., Greenfield, Mass. This rack is made entirely of steel, the different parts of which are punched out on the press. This makes the cost so low that it can be furnished for about the same price as a wooden rack. The separate pieces are punched so as to lock together and in such a way

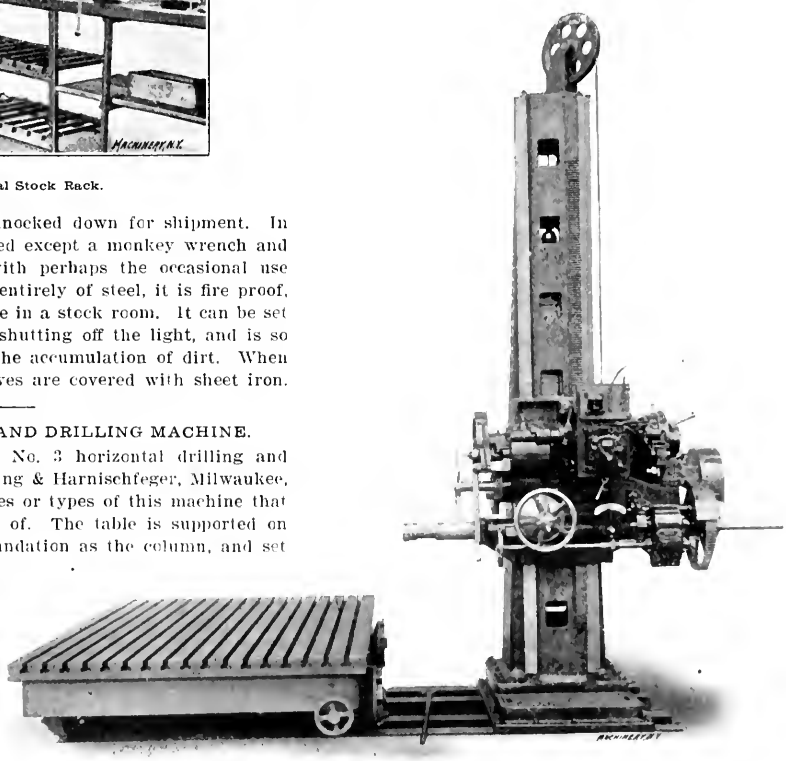


A New Metal Stock Rack.

that the rack can easily be knocked down for shipment. In setting it up, nothing is needed except a monkey wrench and the workman's two hands, with perhaps the occasional use of the hammer. Being made entirely of steel, it is fire proof, and so is very desirable for use in a stock room. It can be set in front of windows without shutting off the light, and is so constructed as to discourage the accumulation of dirt. When used for small parts the shelves are covered with sheet iron.

HORIZONTAL BORING AND DRILLING MACHINE.

The illustration shows the No. 3 horizontal drilling and boring machine built by Pawling & Harnischfeger, Milwaukee, Wis., which is one of four sizes or types of this machine that the builders make a specialty of. The table is supported on rails fastened to the same foundation as the column, and set at right angles to the spindle.



Pawling & Harnischfeger Horizontal Boring and Drilling Macnine

The constant-speed driving motor is fastened to the column carriage and directly geared to speed-change gearing in a revolving case. A spindle speed variation of 7 to 200 revolutions per minute is obtained with this device through eight changes The machine is controlled by a positive clutch, the lever of which is placed conveniently for the quick reversal of the machine when used for tapping.

The column carriage or head is fitted with long bearing surfaces and is counterbalanced. The lowest position of spindle is 17 inches from the floor and an elevation of 8 feet 10 inches above this point can be reached. The table is 6 feet by 8 feet in size, and therefore a working surface of about 70 square feet can be covered with one setting. For long structural work, a small auxiliary table is used in connection with the large table.

The spindle is of large diameter and contained in a substantial cast-iron sleeve. The bearings are bronze, of large area, and end thrust is taken by a ball bearing. The spindle sleeve has a very long bearing and there is an additional bearing for the spindle at the main driving gear, thus giving a rigid alignment at extreme spindle traverse. A cap nut is provided for holding facing bars and counterbores in the taper socket when feeding backwards.

A patented device is employed for locking and unlocking the feed mechanism which requires but a slight movement of the hand wheel for operating the spindle and setting the feed. There are four changes of gear feed for each spindle feed with a feed ratio of 0.008 to 0.07 inch per revolution of spindle.

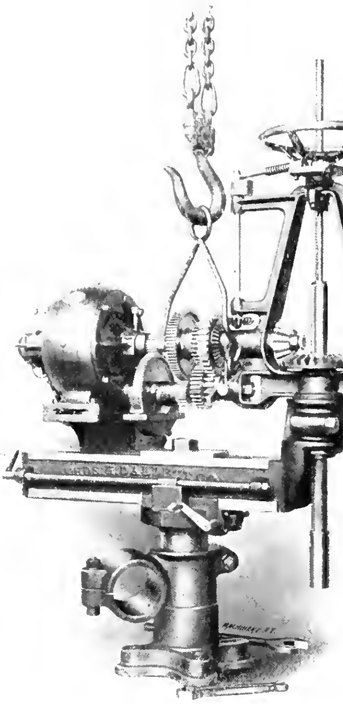
The No. 1 and No. 2 machines have two round columns for supporting the carriage and are belt-driven from a variable speed countershaft which is under immediate control of the operator. The spindle and feed mechanisms are of same design on all machines.

AN ELECTRICALLY-DRIVEN PORTABLE DRILL.

The Thos. H. Dallett Co., of Philadelphia, Pa., have recently made improvements in their line of portable drills. These improvements involved redesigning the entire line and equipping them with a motor drive. As may be seen from the half-tone, the machine is supported by a base containing two bearings, one vertical and one horizontal, an arrangement which allows the machine to be used in either of these two positions. A stem which is clamped in this base carries on its upper end a cap whose periphery is cut with worm teeth. The slide in which the frame of the machine is clamped carries a worm which engages this clamp. The drill may thus be rotated around the base, or moved in or out and clamped in the desired position. The inward and outward adjustment is actuated by a screw.

The motive power for this apparatus is a variable speed motor of sufficient capacity to take the heaviest cuts within the range of the machine without undue heating. Its bearings are arranged to work equally well in whatever position the machine may be mounted. The connection to the drill spindle is through powerful back gearing. The feed of the drill is actuated through a pawl and ratchet mechanism which allows

a variation of from one tooth to seventeen by shifting a thumb latch, no wrench being required for its adjustment. There is a spring connection between the connecting rod and the pawl arm which it actuates and the tension of this spring may be adjusted in such a way as to give any desired amount of pressure to the feed; when this pressure is exceeded the feed becomes inoperative, the spring compressing at each revolution



No. 5 Dallett Portable Drill.

of the feed shaft instead of operating the pawl. A bail is hung in such a way as to allow easy handling of the apparatus by crane or hoist.

This machine at present is made in the No. 4 and 5 sizes. The No. 5 size, which is shown here, has a reach of arm of 36 inches, drilling at one setting over a surface of 72 inches outside diameter and 22½ inches inside diameter. The spindle is provided with a No. 5 Morse taper, has a diameter of 2 1-16 inches and a traverse of 20 inches with a range of speed from 19 to 90 revolutions per minute and feeding from .005 to .075 inch per revolution of the spindle. The net weight of the machine complete is 1,300 pounds.

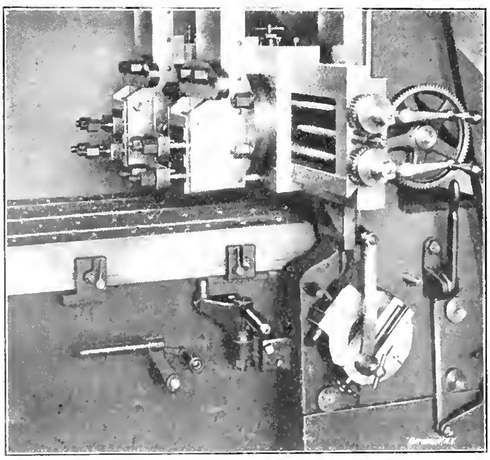


Fig. 1. Improved Shipper Dog as used on the Whitcomb Planer.

A QUICK ADJUSTING PLANER DOG.

Accidents sometimes occur in the use of a monkey wrench or box wrench when adjusting the shipper dogs to change the length of the stroke of the planer table. To obviate this danger and to allow the desired change to be made instantaneously, the locking and releasing being done by the pressure of the fingers only, the following device has been designed. Fig. 1 shows a planer with two of the dogs in position and Fig. 2 shows details of the construction of the clamping mechanism. In Fig. 2, *A* is the platen of the planer with a T-slot at the side in which the dog is clamped. A loose T-head tongue, *C*, fits in this T-slot. The spherically headed clamp nut, *G*, works in a seat in this tongue, and has screwed into it the adjusting screw, *H*, with a spherical head which seats in the body of the dog. Supposing that, as would be the case here, the blow of the shipper lever were in the direction of

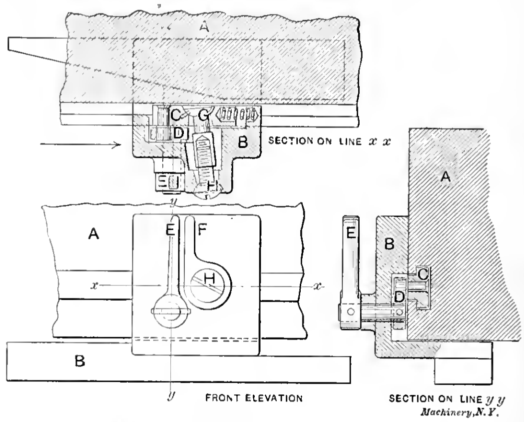


Fig. 2. Clamping Mechanism of Planer Dog.

the arrow shown in the top view. It is evident that this blow would make the clamp nut and its adjusting screw act as a toggle, thus firmly binding the dog to the table, being assisted in this operation by the pressure of the spring at the rear. When the workman desires to release the dog, lug *F* and lever *E* are grasped between the thumb and forefinger. Lever *E*, through the rock shaft to which it is pinned, rotates slightly the slotted arm, *D*, which in turn clasps a dowel which is riveted in the tongue, thus moving it to the left and freeing it from the tension of the clamp nut and adjusting screw. As soon as the pressure of the fingers is released the spring again forces the tongue to the left thus tightening the dog in its place, each successive blow from the shipper lever only serving to seat it more firmly. This arrangement is being applied by the Whitcomb-Blaisdell Machine Tool Co., of Worcester, Mass., to their line of Whitcomb planers.

THE PRENTICE AUTOMATIC TURRET MACHINE.

George G. Prentice & Co., New Haven, Conn., are building an automatic turret machine, of which a half-tone is shown in Fig. 1. The machine is used particularly for finishing brass, cast-iron and malleable-iron castings, and for doing second operation work on pieces made from bar stock. Its construction, however, is such that it may be adapted to a great many other uses. The machine consists essentially of a chuck, *A*, for holding the work, which can be revolved to bring successive tools into operation, and which can be moved in and out for the feeding of the tools; and in combination with this a series of spindles located at the left end of the machine in such a position as to coincide with the different positions of the work in the chuck. In the machine, as shown, there are four rotating tool spindles and five sets of jaws in the chuck. This latter is shown in detail in Fig. 2. A large face plate is slotted to receive five sets of double jaws which may be tightened on the work by means of right and left-hand screws. These jaws are dove-tailed to receive false jaws which may be bored or shaped to fit the contour of the work which it is desired to operate upon.

The long cast-iron sleeve, *G*, on the end of which this chuck is mounted, carries at its outer end the star wheel of a Geneva

stop motion, *J*, and a locking wheel, *K*, this mechanism being used for rotating the work from one position to another. The indexing mechanism is controlled by a long cam shaft running the length of the machine and driven by a worm and worm wheel *F*, which receives its motion from one of the spindles. When the machine is in operation this cam shaft rotates continuously unless thrown out of gear by the handle shown at the front of the bed.

There are four spindles in the form of machine here described. Of these, the one on the front side is driven by pulley *D*, the two lower ones by pulley *E*, while the further spindle, which is used for threading, is driven by the reversing pulleys, *C*. The various spindles may thus be given speeds to suit the tools which they carry.

The first member on the cam shaft, beginning at the right, is a disk carrying adjustable dogs for reversing the threading spindle. Next to that comes a cam which operates, through levers which may be plainly seen, the chuck rest, *B*. Since all the spindles revolve in one direction the pressure of the cut tends to rotate the work and the chuck in which it is mounted in such a way that the face of the notch cut in the face plate is brought down against this rest. These notches are milled with great accuracy to insure the alignment of the spindles with the work in the different positions. The top of the rest is in the form of a hardened shoe which has a taper adjustment by which it may be brought to the right

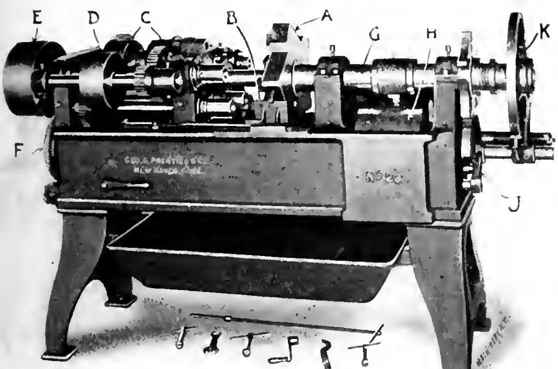


Fig. 1. The Prentice Automatic Turret Lathe.

height as the surface wears away. The office of the cam is to withdraw this rest just before the chuck is rotated by the indexing mechanism. Immediately under the tools is a drum on the camshaft which carries cams controlling the movement of the tap or die on the threading spindle, it being possible to use either the tap or die alone, or both together. A forked lever encircles the tap or die holder and carries at its lower end a roll engaged with the before-mentioned cam. The tap or die holder is free to slide on the spindle. This arrangement gives a positive lead to the threading tools, no matter what the feed for the turning tools may be. Since it is necessary that this lead be kept constant the cam shaft mechanism is generally driven from the threading spindle. When the tap and die holder are used together two cams and two forked levers are provided, a form of holder being used which will support both a tap and a die and allow them to act independently. At *H* may be seen a drum on which is mounted the feed cam. This cam is proportioned to give a thread long enough to take the longest cut necessary to finish the piece, and the proper feed is obtained by change gearing between the threading spindle and the worm shaft which drives the worm wheel, *F*. A sleeve on the chuck spindle carries the roller through which motion is communicated to the work, while the back thrust on the cam is taken care of by a second roller which may be seen in the cut near the right-hand bearing pedestal. The outer end of the cam shaft carries the indexing and locking mechanism, before described.

Much thought has been given to the design of the tools used with this machine. The combined tap and die holder has been mentioned. It is not necessary in using this tool that the external and internal thread should have the same pitch or the same length, the only requirement being they should both be the same hand. By using, however, an opening die holder on one of the spindles it would, of course, be possible to cut right and left-hand threads. The turning tools are so designed as to make use of self-hardening steel blades broken off from the bar and placed in the holder with no other machining than the simple removing of the scale and the grinding of the cutting edge of the desired angle. An example of one of these tools is shown in Fig. 3. This consists of a shank and body split in two parts, as may be seen in the end view, to allow a groove to be milled to receive the blade

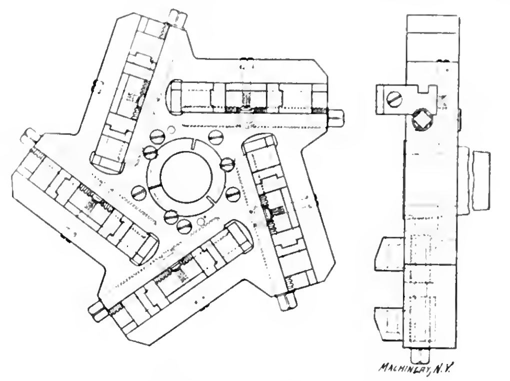


Fig. 2. Face Plate and Chuck Jaws for Holding Work.

of self-hardening steel which acts as a core drill. In the body are mounted four inclined blades whose ends are ground to perform the different functions of counterboring, chamfering the edge of the hole, facing the outer end of the casting and beveling the outside edge. By making the tool holders in this way the cost of replacing worn-out cutters is reduced to the smallest degree possible. Some of the other tools regularly furnished with the machines are, a cross-cutting tool for necking back of threads, etc., an automatic opening and hollow mill, universal adjustable box tool, and holders for solid reversing taps and dies. In the operation on small castings, such as pipe and valve fittings, injector parts, etc., the capacity of the machine is limited only by the ability of the workman to fasten the work into and take the work out of the machine. In second operation work on steel, for which a slightly different form of chuck or face plate is provided, the

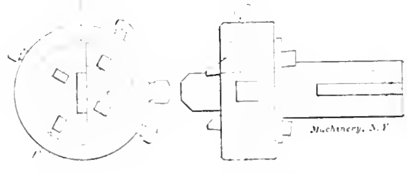


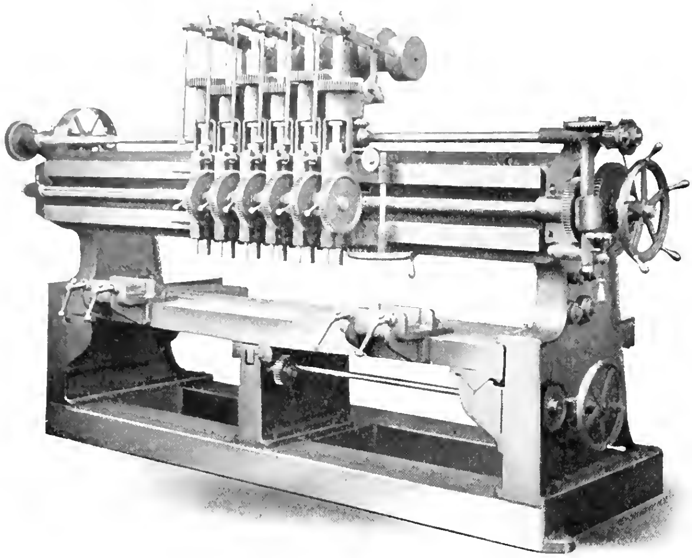
Fig. 3. An Example of the Toolholder Construction.

cuts are sometimes long enough so that one man can run two machines to advantage. The reason for providing five sets of chuck jaws and only four spindles is to allow a position where work will not be acted upon by the tool, thus permitting the workman time to change the work. The machine is not limited to the form we have shown, but may be furnished with three, four, five, six, or even more spindles when necessary, or may be made double ended with a revolving chuck in the center which grasps the work by the middle, allowing the ends to project each side, so as to be operated on at both ends simultaneously. Other arrangements for driving the spindles are also furnished to suit special work, but the machine as described is that which has been found useful for the production of the greatest variety of work.

A MULTIPLE-SPINDLE MUD RING DRILL.

This multiple-spindle drill press, while especially designed for handling the work indicated by its name, is equally well adapted to other operations requiring the drilling of a num-

ber of holes in one line. Instead of having the heads slide on an auxiliary rail, as is usual, they are directly adjustable on the main rail, thus enabling them to be spread to any desired center distance, by means of the independent adjustment provided. When it is necessary to move the heads on the rail collectively they may be clamped together by quick-acting nuts to the desired center distance apart; a dial on the worm



The Bickford Mud Ring Drill.

wheel in the upper corner of the right-hand head shows the distance to be moved to the right or to the left.

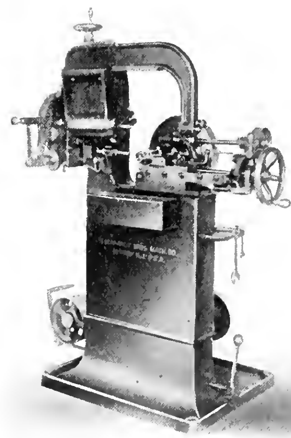
The speed and feed changes are obtained by means of change gears held in position by spring plungers, thus enabling the operator to change quickly from one speed to another without lessening the available power of the machine. A dial on the large worm wheel at the right shows where to set the dog to trip the feed at any desired depth. The spindles are 1 15-16 inch in diameter with a vertical movement of 12 inches, and they work to a maximum center distance of 26¼ inches. The table has a traverse movement of 24 inches and when built with a 12-foot rail will take 10 feet 6 inches between the housings. Since it is driven by a constant pulley, the power is never less than that obtainable from a 5-inch double belt running at 1,619 feet per minute. The net weight of the machine is 17,500 pounds. This machine is one of the products of the Bickford Drill & Tool Co., Cincinnati, Ohio.

A SIMPLE SPUR AND BEVEL GEAR CUTTING MACHINE.

The Eberhardt Bros. Machine Co., of Newark, N. J., have designed and are putting on the market a gear cutter for handling spur and bevel gears up to twenty inches in diameter. The purpose of the makers was to produce a machine which should be as simple and inexpensive as possible and yet meet exacting requirements as to accuracy and output. The machine is not full automatic, though it requires so little attention that a boy may run several of them. As may be seen in Fig. 2, which shows the rear side of the machine, the drive is by means of belts with the speed change obtained by cone pulleys, and a take-up arrangement is provided for keeping the driving belt tight no matter what the position of the cutter slide may be, using endless belts throughout. The cutter slide may be tipped to an angle of 90 degrees for cutting bevel gears. The feed is thrown out automatically at the end of the cut. The lower slide is independently adjustable along the base to suit varying lengths of hub.

An important feature of the machine is the arrangement provided for indexing. In the hands of boys or unskilled men the arrangement used on the milling machine is liable to error, since it is easy to make a mistake and not drop the index pin into the right hole. On this machine, however, the indexing is done by one or more full turns of the indexing crank, change gears being provided for the different numbers of teeth. The index wheel is made in halves and special care is taken to have it accurate within very fine limits. The first gashing of the wheel is done with only commercial accuracy so far as the spacing is concerned. In bringing the spacing to the degree of refinement required for an index wheel, the teeth are finished in place by a hob having but a slight degree of relief. After the teeth have been gashed the two sections of the wheel are moved to a second position with relation to each other, the teeth being averaged up all around in the circumference to match with each other as nearly as possible. A cut is then taken with the hob to bring the indexing a degree nearer perfection than it was before. The two halves of the wheel are then moved to a third position in relation to each other and the tooth errors average up as above. After repeating this process as many times as there are possible adjustments of the two parts of the wheel, the error is reduced to a point far below that required for commercial work.

The machine shown has a capacity for gears twenty inches in diameter and five inches face. It will cut eight diametrical pitch from the solid in steel and six diametrical pitch from the solid in cast iron. The work spindle is of steel and is provided with a No. 10 Brown & Sharpe taper hole for receiving the various work arbors. A drawn-in bolt is provided by means of which the work arbors may be drawn in or forced out positively without hammering.



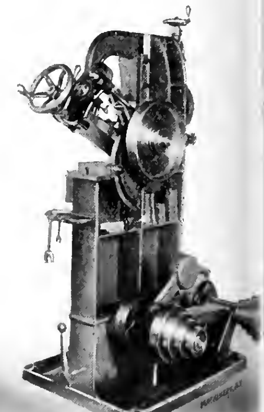


Fig. 1. Fig. 2.

Eberhardt Bros. Spur and Bevel Gear Cutting Machine.

A lathe center with dog driver is furnished for holding work on centers in connection with the outside support. This permits the cutting of gears on ordinary lathe mandrels and the doing of miscellaneous work such as cutting solid pinions, taps, reamers, etc.

A SPECIAL THREAD-ROLLING AND CUT-OFF ATTACHMENT FOR THE AUTOMATIC SCREW MACHINE.

In making work of the class shown in Fig. 1 on the automatic screw machine, if it is desired to turn out the part complete at one operation, it must be made as shown, with the counterbored portion at the outer end and the threaded end next to the chuck; this necessitates the use of special tools for cutting the thread. Such a tool is that shown in Fig. 2, which is used by the Cleveland Automatic Machine Co., Cleveland, Ohio, for doing this kind of work on their automatic screw machine. The thread is cut by rolling in a manner

somewhat similar to that in use for threading bicycle spokes, small screws, etc., except that the die in this case instead of being a flat plate with V-grooves milled in it, is a circular tool with a thread cut on its outside diameter as shown at *D* in Fig. 2. This roll, which is carried across underneath the work at *B*, is made of a diameter two, three, or four times as large as the work, thus having a double, triple, or quadruple

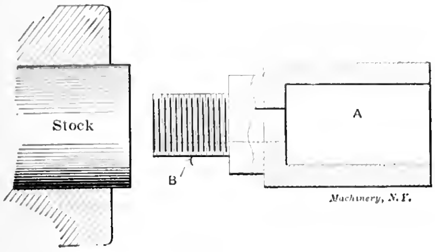


Fig. 1. Type of Work requiring the use of Thread Rolling Attachment.

thread cut upon it. For instance, if it be desired to roll a thread a half inch in diameter by sixteen pitch, the tool may be made one inch in diameter, eight turns per inch, with a double thread. If the work is threaded right-hand the tool must, of course, have a left-hand thread. This thread roll is mounted on an arm which is adjustable about the center of the cut-off tool by means of nuts, *A A*, one of which may be loosened and the other tightened to bring the tool into position to cut the desired depth. After the adjustment has been made, cap screw *C* is adjusted to support the tool under the

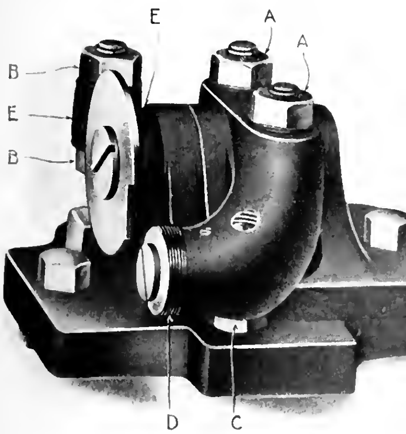


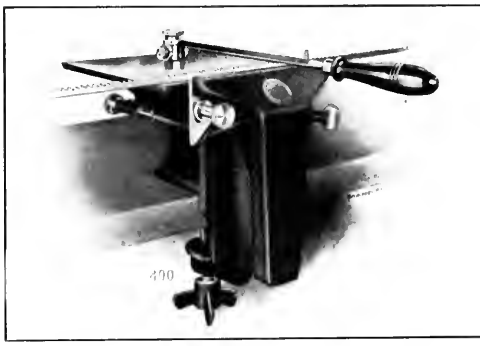
Fig. 2. Combined Tool Post for Thread Roll and Cut-off Tool.

pressure of the cut. In this tool is incorporated the regular mechanism used on the Cleveland automatic screw machine for supporting and adjusting circular cut-off and forming tools. The tool has formed in its side a series of ratchet teeth which mesh with similar teeth on lever *E E* in such a way that they are firmly bound together, and when lever *E E* is slightly turned about its axis the tool is turned also. To adjust the tool to bring its cutting edge to the center after grinding, one of the two nuts *B B* is loosened and the other tightened until the desired adjustment has been affected. This arrangement also serves to prevent the tool from slipping under the pressure of a heavy cut.

BAND SAW FILING DEVICE.

A neat and simple saw filing device has been brought out by the New Britain Machine Co., New Britain, Conn. Its purpose is to serve as a mechanical guide for the hand filing of band saws and it is said by the makers that results are secured superior to those obtained with power filing machines. The latter usually file the top of the teeth first and the cutting edge last. This causes the burr formed at the point of the tooth to be thrown outward at right angles to the blade, where it will be broken off as soon as the saw begins to run, leaving a dull point. If, however, the top of the tooth is filed last, as can be done in hand filing, the burr will extend in a direction lengthwise of the blade; in position it will be longer maintained and act as a keen cutting point.

In the New Britain device the band saw is held in an automatically operating vise, with hardened and ground jaws. A slight pressure of the file from left to right will carry a saw along with it as pressure in this direction tends to release the jaws and to permit the saw to slip. Attached to the vise is a horizontal table and this in connection with a roller guide fastened to the small end of the file constitutes the chief novelty of the device. This roller guide can be adjusted to support the file at any desired level and also will hold it at the proper angle for the desired hook to the teeth. These two adjustments may be changed with relation to each other and the file then securely clamped by setscrews. The hardened rollers of the guide travel on the face of the polished table and do not impede its action, yet they compel the work-



Band Saw Filing Device.

men to maintain the file in the correct position throughout the full length of the stroke. The whole process is therefore mechanically carried on except that of holding the file at right angles to the saw and the eye is, of course, a sufficient guide to accomplish this. The only adjustment that need be made is in setting the under gage to the back of the saw so that the teeth will project just enough to allow the file to pass freely through. This gage works in parallelism and is held by a single thumbscrew, for adjustment for different thickness of saws if necessary.

In order to maintain the saw teeth at a uniform height a piece of emery or stone should be brought up lightly against them while the saw is running and before it is removed from the machine for filing. This will indicate to the workman the point to which each tooth is to be sharpened and this guide, together with the fact that the teeth are always presented at a uniform height above the jaws by means of the under gage, enables him to secure uniformity.

TWO NEW INSERTED TOOL HOLDERS.

The accompanying cuts show two examples from a line of tool holders recently put on the market by the Bown Machine Co., Ltd., of Battle Creek, Mich. Fig. 1 is a side tool holder provided with a double ended blade. This, in combination with the swiveling head, allows the tool to be used either as straight right-hand, straight left-hand, offset right-hand, or offset left-hand of any desired depth of cut. The blade is made

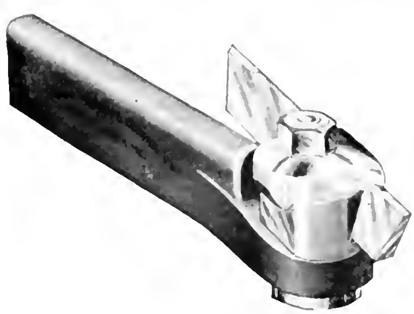


Fig 1 Combination Side Tool Holder

of high-speed steel. The holder itself is a drop forging from machinery steel, case hardened, the post and cap are machinery steel, and the collar is of hardened tool steel. The blade is supported on three surfaces in such a way as to be firmly held when the nut is tightened up.

Fig. 2 shows a planer tool. A novel feature of its construction is the provision made for varying the top rake of the

Fig. 2. Planer Tool with Adjustable Top Rake.

blade. By means of a tipping piece, similar to that in the regular lathe tool post, in combination with a swiveling clamp, the blade may be fastened firmly in any position desired. These tool holders are sent on approval and may be returned after examination if unsatisfactory, and the money will be refunded; or if one is broken by flaws in the metal, it will be replaced by the makers.

* * *

FRESH FROM THE PRESS.

PRACTICAL PATTERNMAKING, by Paul N. Hasluck. 160 pages 4¾ x 7 inches. 300 illustrations. Published in America by David McKay, Philadelphia. Price $1.

The author, who is a well-known English writer of books on technical instruction, treats of patternmaking from an English standpoint, and gives much interesting and valuable material that should be appreciated by the patternmaking craft generally and especially by apprentices and those who have not had the advantages of complete instruction. The book is copiously illustrated with pen sketches which show the various parts, and patterns for same, that were chosen for purpose of illustration. While some of these sketches are not drawn correctly, according to the recognized methods of mechanical delineation, as for example, the undercut of the pattern shown on page 42, they, in general, are clear. The book contains thirteen chapters as follows: Foundry Patterns and Foundry Practice, Jointing-up Patterns, Finishing Patterns, Circular Patterns, Making Core-boxes, Coring Holes in Castings, Pattern and Moulds for Iron Columns, Steam-engine Cylinder Patterns and Core-boxes, Worm Wheel Pattern, Lathe-bed Patterns, Headstock and Poppet Patterns, Slide-rest Patterns, Miscellaneous Patterns and Core-boxes.

THE SACRAMENTO VALLEY OF CALIFORNIA, by A. J. Wells. 112 pages, 4¾ x 6¾ inches. Illustrated with 116 half-tone illustrations and two maps. Published by the Southern Pacific Co., San Francisco, Cal. Price 10 cents.

This little booklet is issued by the Southern Pacific Co. to advertise the great empire of the Sacramento Valley of California. It is a well-written and beautifully illustrated booklet, and to any one interested in the possibilities of agricultural life in California it will prove valuable and interesting, and to any one else interested in the resources of this country in general, this book should be perused with profit. Mr. Wells' description of this section of California is detailed and care has been taken to make it thoroughly reliable and authoritative, avoiding exaggeration and matters that might be misleading. In addition to the descriptive portions the writer has given special chapters such as "A Great Empire and a Great Opportunity," "Why is the Valley not Densely Settled," "Cash Value of Climate," and "Social Life." A chapter of special interest in view of the reclamation work of the States and United States Government, is that on "The Delta Lands of the Sacramento." This chapter contains a good map of the region.

MODERN LOCOMOTIVE ENGINEERING, by C. F. Swingle. 630 pages 4¾ x 6½ inches; 265 engravings, bound in seal grain leather with flap and pocket. Title printed on cover in gilt edges. Published by Frederick J. Drake & Co., Chicago, Ill. Price $3.00.

The book is a "treatise" on the construction, care and management of the locomotive, to which is added a comprehensive chapter on the air brake, including the Westinghouse and New York systems. The subjects are not presented in the catechism style, but each chapter is followed by a list of questions which have their answers in the preceding text. The first chapter, Fireman's Duties, contains more technical matter perhaps than the average fireman would care about, but if he desire to obtain a knowledge of the theory of the steam engine it has none too much, being in fact, quite elementary from the theoretical standpoint. Following this chapter come the Boiler, Throttle and Dry Pipe; Valves and Valve Gear; Valve Setting; Piston Valves and Balanced Valves; The Indicator; Compound Locomotives; Injectors, Steam Gages, Pop Valve and Fittings; What to Do in Case of Breakdown; and The Modern Automatic Air Brake. Six folding plates are included, two of which are placed in the cover pocket. Judging from the somewhat critical examination we have given the chapter on valve setting, we think that the book is an unusually practical one and one that the railway foreman, engineer, machinist and master mechanic can possess with profit. It is not, as might be thought from the style of binding, a locomotive handbook containing a lot of condensed and tabulated data, but is a clear and interesting treatment of the subjects given above, written in an unusually readable style.

MACHINE DESIGN, by Albert E. Smith, Director of Sibley College, Cornell University, and Guido H. Marx, Associate Professor of Mechanical Engineering, Leland Stanford Jr. University, California. Published by John Wiley & Sons, New York. 369-8vo. pages, illustrated. Price $3.00.

This is primarily a text book for students' use. We have at various times heard favorable comment upon Prof. Smith's notes upon kinematics and machine design which he used when in California previous to taking the directorship of Sibley College. Now that they have been revised and supplemented by additional matter, sufficient to produce a text book, we believe they will meet with even greater favor than heretofore. The book is a model of conciseness and exact statements. It is entirely free from padding and adheres strictly to fundamental principles. In fact, a critic might say that it erred on this side, if at all. The first four chapters are devoted to a very brief treatment of the principles of kinematics; then follows a chapter upon the proportions of machine parts as dictated by stress, which gives the student an idea of the effects of repeated stress, shocks, steady loads, appropriate factors of safety, etc. After this the different machine parts are taken up in the following order: Riveted Joints; Bolts and Screws; Keys; Sliding Surfaces, Axles and Shafts; Journals and Bearings; Roller and Ball Bearings; Couplings and Clutches; Belts; Fly Wheels; Gearing; Springs; Machine Supports; and Machine Frames, the latter including, also, the subject of cranes. In many instances examples are worked out under the different formulas. For example, under the subject of belting, the case is taken of a single-acting pump of a certain size, which is to deliver a certain quantity of water against a given head. The pump is to be belt driven and the problem is to determine the width of the belt. By such problems as these the authors have indicated ways in which the book can be made of much practical value to the student, since the problems are of a character to suggest to instructors the kind of examples that are likely to prove of greatest benefit to the student.

NEW TRADE LITERATURE.

The American Locomotive Co., 111 Broadway, New York, have sent us a pamphlet containing a description of the Mallet articulated compound locomotive. This type of locomotive has been used in certain mountainous sections of Europe for several years past, but it is only recently that any noteworthy use was made of it in the United States, and that is the four-cylinder articulated compound freight locomotive built by the American Locomotive Co. for the Baltimore & Ohio Railroad about two years ago, and exhibited at the Louisiana Purchase Exposition of 1904. It is the heaviest and most powerful locomotive ever built, having a total weight of engine and tender of 477,500 pounds, of which 334,600 pounds are on the drivers. The maximum traction power when working compound is 71,500 pounds. The pamphlet is illustrated with half-tones and line drawings which are described in the accompanying text. It concludes with a number of interesting comments which appeared in various railway papers. The pamphlet is one well worth attention, for if we are not mistaken the type of locomotive which it describes will come to have considerable use on trunk lines having heavy traffic and stiff grades.

MANUFACTURERS' NOTES.

L. H. GILMER & CO., Philadelphia, Pa., have moved from Market St. into larger quarters in a more central location. Their new address is 504 Arch St., Philadelphia.

KEARNEY & TRECKER, Milwaukee, Wis., have recently completed a large addition to their shop, which will enable them to handle more easily their rapidly increasing business.

HISEY-WOLF MACHINE CO., Cincinnati, O., last month made the largest shipment of tools in their history. Their business is constantly increasing.

MACHINERY.

January, 1906.

TEN-THOUSAND HORSE POWER ROLLING-MILL ENGINE.

CHARLES R. KING

On the continent of Europe the number of very large rolling-mill engines is small. The visitor to Krupp's Essen-Ruhr works finds there but a collection of old, out-of-date machines, and at the great steel works of Cockerill, which is built upon the site of its own coal mines, the largest reversing rolling-mill engine in use up to this year was of only 1,800 horse power. In less celebrated works, as for instance, the Diosgyor forges belonging to the Hungarian State Railroads, there are single-expansion reversing engines of 4,200 effective horse power, while in France the great works, at Creusot, have an engine of about 8,000 horse power for armor-plate rolling; and several other firms of less note in France have machines of English build indicating a yet higher power.

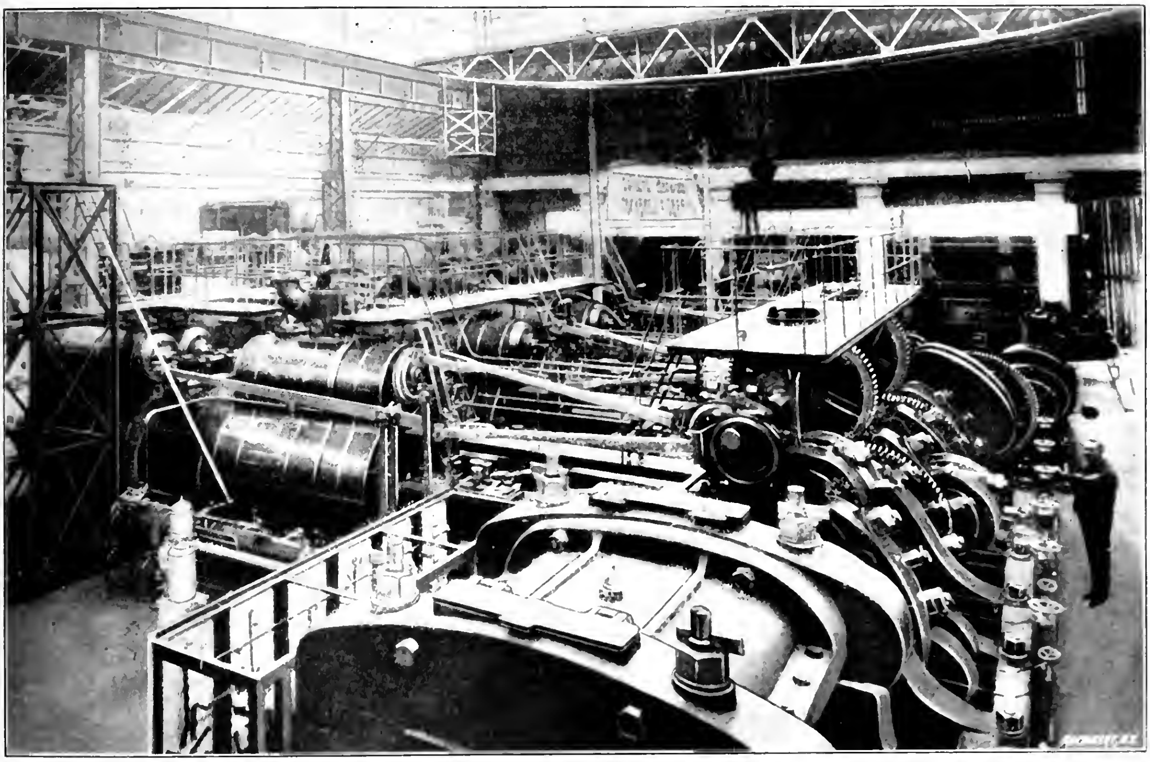


Fig. 1. The Cockerill Ten Thousand Horse Power Rolling Mill Engine.

An engine of about 8,000 effective horse power, or of 10,000 indicated horse power, at 120 revolutions, with an initial steam-pressure of $117\frac{1}{2}$ pounds, has recently been built by the firm of John Cockerill at Seraing, near Liege, for operating its blooming and girder mills at Seraing in place of the small units hitherto employed.

This type of machine is novel, being a triple, tandem engine with six cylinders, having only three cranks, set at angles of 120 degrees. The steam distribution is effected by piston-valves throughout; that is, one piston valve for each high-pressure cylinder in front, and two valves, set side by side, for each low-pressure cylinder at the back of the machine. In this way all the piston valves are of the same diameter (13 inches) and, being identical, are perfectly interchangeable. By this arrangement, also, sufficient port areas have been provided without introducing inconveniently large valve chests. All three valve-spindles in each tandem group are actuated from rocker-shafts carried in bearings bolted on the casting which connects the front and back groups of cylinders and each valve rod takes its motion from a link of the Allen type as shown clearly in the view, Fig. 1.

The eccentric shaft is, it will be seen, driven by two pairs of spur wheels from the crankshaft. Reversing is effected from the horizontal steam assistant engine shown on the left-hand side, and at the base of the cylinder. From the high pulpit or staging erected on the left-hand side the engineer has a clear view of each set of valve gears, Fig. 1, placed, as they are, to the right of each pair of tandem cylinders. This elevation enables him to observe the operations on the rolling-mill floor. For the inspection of the engine a series of bridges and gang-ways is provided, giving access to all parts of the engine. Shaded incandescent lamps will illuminate all the working parts at night or in dull weather.

The throttle rod for opening the valve of the small assistant motor is visible in the photographic view. The piston of this motor acts upon an angle-crank (hidden from view in the engraving) in connection with the vertical rods and the link blocks—both visible. Another lever on the engineer's platform connects, by rod, to the throttle of a vertical assistant motor which is bolted to the front side of the steeple-shaped drop-seat valve chamber of the middle low-pressure cylinder; and this motor is connected through cranks and horizontal rods to the drop-seat admission-valves of the high-pressure cylinders, for starting the engine. The drop-seat main steam valves, in the outside casings of the high-pressure valve-chests are $10\frac{1}{4}$ inches diameter, and the steam pipes (disconnected in the view) are $10\frac{5}{8}$ inches diameter. Differing in this respect, the drop-seat valves $17\frac{1}{4}$ inches diameter, of the low-pressure, are fitted in the piston valve chests be-

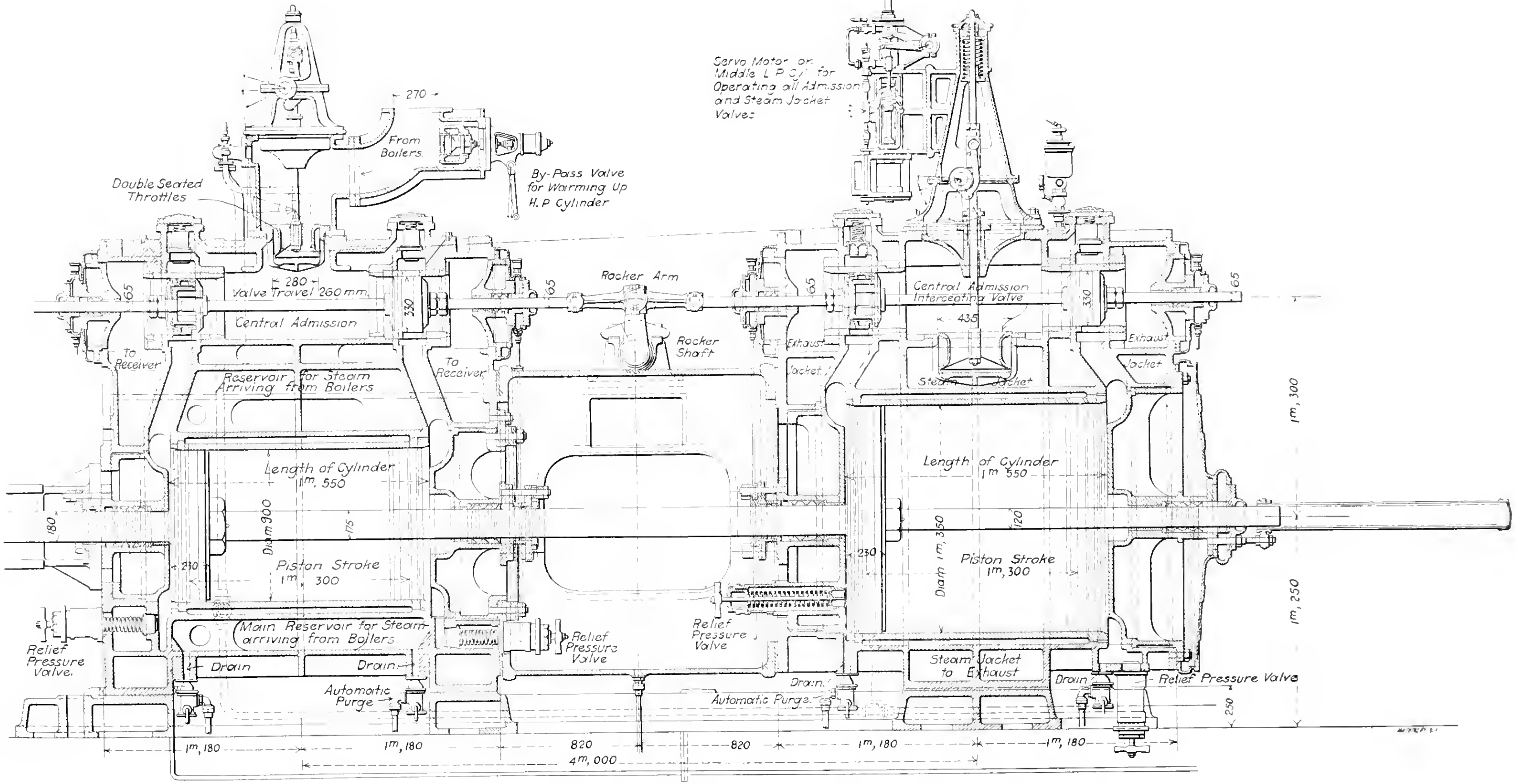


Fig. 2. Longitudinal Section through Cylinders and Valve Chests.

tween the latter and the cylinder, the object of the arrangement being to cut-off the steam from the steam-jackets of the low-pressure cylinders simultaneously with the closing of the drop-valves (throttles) on the high-pressure cylinders. Both the cylinders and the valve chests are steam jacketed, those of the high-pressure cylinders being opened to steam direct by means of the admission valve, while in the low-pressure cylinders it is the exhaust therefrom which warms the jackets. During or after prolonged stops there would be an excessive condensation in the voluminous jackets of the low-pressure cylinders, causing a drop in the pressure of the reservoirs, and so to obviate this the Société John Cockerill patented in 1882 the arrangement above described, which is automatic in action. To warm up the cylinders before starting, steam is admitted by means of a small valve and by special pipes to the high pressure jackets. The half-tone illustration was taken while the engine was on exhibition and the pipes are not shown fitted up, as the machine is simply run from a small electric motor to avoid the intolerable heat to visitors which would be caused by such a large machine in motion.

The usual reservoirs for the steam in most rolling engines are here constituted by the great capacity of the jackets combined with the length of the steam pipes from the boilers.

The exhaust (from the low pressure jackets) is directed through two pipes of 25½ inches diameter, one on each side of the middle low-pressure cylinder, and thence escaping to the air.

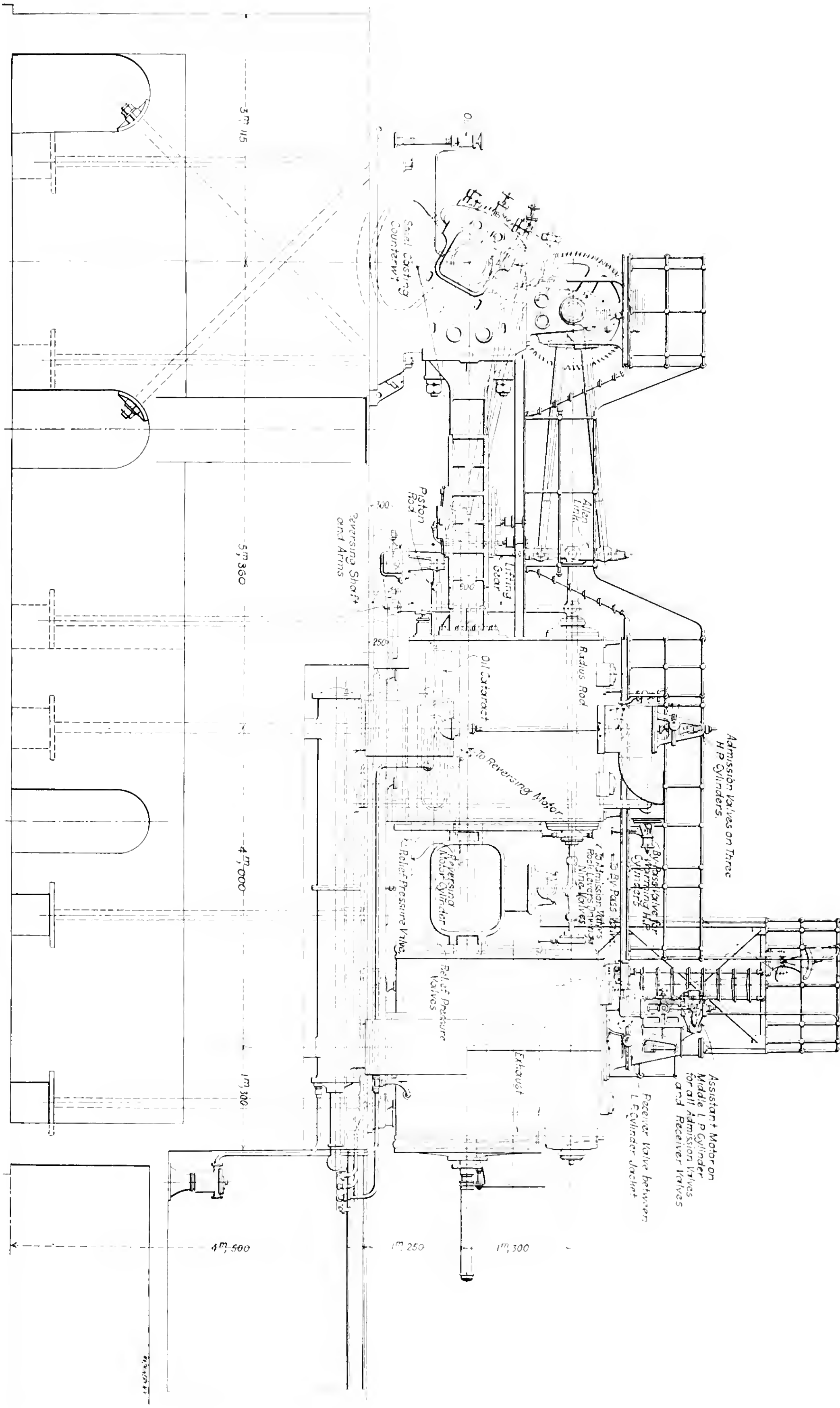


Fig. 3. Side Elevation of Ten-thousand Horse Power Rolling-mill Engine and its Foundations.

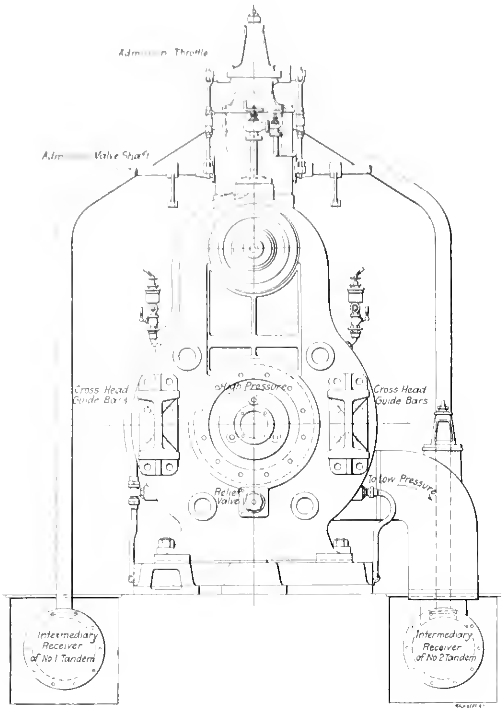


Fig. 4. End View of High Pressure Cylinder.

The cylinders are 35½ inches and 53¼ inches diameter and the piston stroke is 51 inches. Relief pressure valves are fitted to all the cylinder covers, the discharge going direct to the exhaust passages.

There is no bed-plate to the engine, the cylinders being anchored direct to the masonry foundations, as are also the thrust bracket of the crankshaft. The only connections between cylinders and crank-shaft pedestals are the ribbed I-section steel castings 19¾ inches in depth by 12 inches wide, two to each cylinder, which form the guide bars for the piston cross heads. These guide bars are spaced 55 inches between their center lines. The slippers of the piston cross-heads clasp the two edges of these beams. The main driving rods are relatively short, 10 feet, and the piston rods are 7⅛ inches diameter.

The crank-throws and the counter-weights are one-piece steel castings built up with forged steel pins of 17 inches diameter, which is the diameter, also, of the crank shaft.

The crankshaft pedestal bases are all solidly bolted together in a transverse line. The total width of this piece, which is the maximum width of the group of cylinders, is 17 feet 6 inches, the length of the engine is 43 feet, but the height from the floor to the top of the cylinder casing is only 9 feet 10 inches.

The sheathing plates or laggings are of polished "Russia" iron, which gives the machine a neat appearance.

The engine shaft connects with the mill shaft through gear wheels, the box containing which is conspicuous in the foreground of our illustration.

* * *

The effect of cutting a V-thread on a bolt is nearly the same as for a circumferential groove of the same form as the thread groove. It has been found by experimental investigations, says Prof. Jones in his book, "Machine Design, Part II.," that on account of the strengthening effect of the thread, with fairly good rubbing surfaces reasonably well lubricated, the

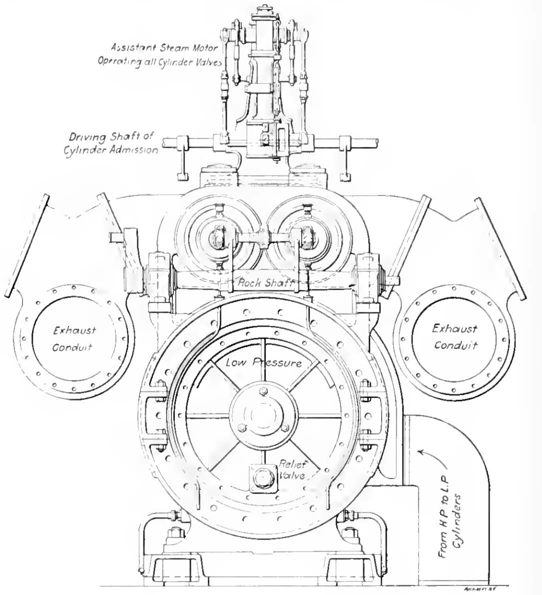


Fig. 5. End View of Low Pressure Cylinder.

axial tensile strength per square inch which will cause rupture in a U. S. standard screw bolt while tightening the nut, is practically the same as the breaking strength per square inch of the body of the bolt. This means that the twisting effect of the nut may be neglected.

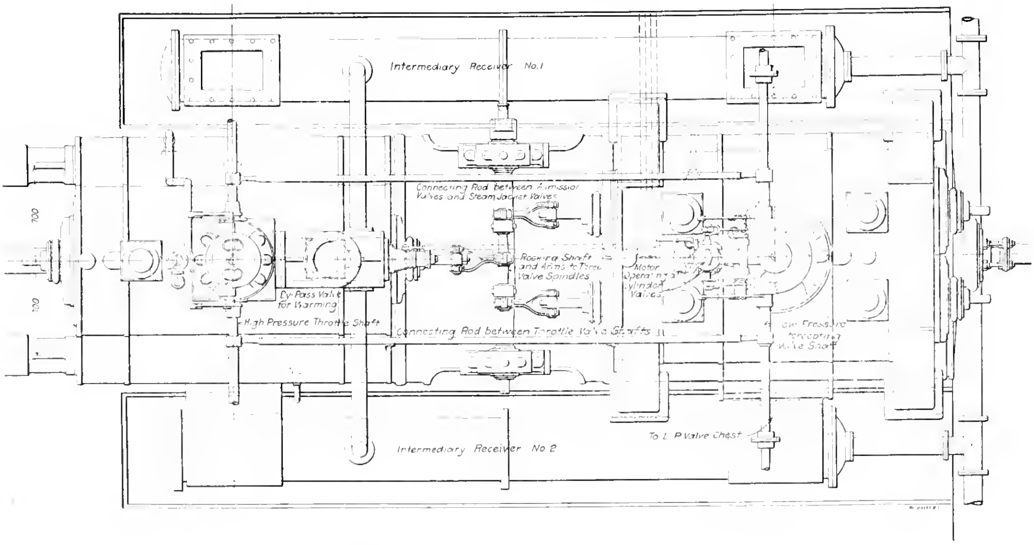


Fig. 6. Plan of Cylinders and Valve Connections.

THE CHOICE OF A FACTOR OF SAFETY FOR A MACHINE MEMBER.

FORREST E. CARDULLO.

It is the custom among most firms engaged in the designing f machinery to settle upon certain stresses* as proper for iven materials in given classes of work. These stresses are hosen as the result of many years of experience on their wn part, or of observation of the successful experience of thers, and so long as the quality of the material remains nchanged, and the service does not vary in character, the ıethod is eminently satisfactory.

Progress, however, brings up new service for which prece-ent is lacking, and materials of different qualities, either etter or cheaper, for which the safe working stresses have ot been determined, and the designer is compelled to deter-ıine the stress proper for the work in hand by using a o-called "factor of safety." The name "factor of safety" is ıisleading for several reasons. In the first place, it is not factor at all, but is in its use a divisor, and in its deriva-ion a product. In order to obtain the safe working stress, 'e divide the ultimate strength of the material by the proper factor of safety," and in order to obtain this factor of safety 'e multiply together several factors which depend in turn pon the qualities of the material, and the conditions of serv-ce. So our factor of safety is both a product and a divisor, ut it is not a factor. Then again, we infer, naturally, that 'ith a factor of twelve, say, we could increase the load upon machine member to twelve times its ordinary amount before upture would occur, when, as a matter of fact, if the usual ɔad were doubled the piece would very soon rupture. The ıargin of safety is apparent, not real, and I will therefore all the quantity we are dealing with the "apparent factor f safety, for the name factor is, I am sure, too firmly fixed ı our minds for either my readers or myself to easily throw off.

The apparent factor of safety, as has been intimated, is the roduct of four factors, which for the purpose of our discus-ion, I will designate as factors a, b, c and d. Factors b and c, s will appear later, may be, and often are 1, but none the ess they must always be considered and given their proper alues. Designating the apparent factor of safety by F, we ave then

$$F = a \times b \times c \times d.$$

The first of these factors, a, is the ratio of the ultimate trength of the material to its elastic limit. By the elastic mit I do not mean the yield point, but the true elastic limit 'ithin which the material is, in so far as we can discover, erfectly elastic, and takes no permanent set. There are sev-ral reasons for keeping the working stress within this limit, ıe two most important being: First, that the material will ıpture if strained repeatedly beyond this limit; and second, ıat the form and dimensions of the piece would be destroyed nder the same circumstances. If a piece of wire be bent ackward and forward in a vise, we all know that it will soon reak. And no matter how little we bend it, provided only that we bend it sufficiently to prevent it from entirely recovering its straightness, it will still break if we continue the operation long enough. And similarly, if the axle of a car, the piston rod of an engine, or whatever piece we choose, be strained time after time beyond this limit of elasticity, no matter how little, it will inevitably break. Or suppose, as is the case with a boiler, that the load is only a steady and unremitting pressure. The yielding of the material will open up the seams, allowing leakage. It will throw the strains upon the shorter braces more than upon the others, thus rupturing them in detail, and I could go on to mention a dozen other disagreeable things that would result. It is absolutely necessary, therefore, excepting in very exceptional cases, that we limit our working stress to less than the elastic limit of the material.

Among French designers it is customary to deal entirely with the elastic limit of the material, instead of the ultimate strength, and with such a procedure no such factor as we have been discussing would ever appear in the makeup of our apparent factor of safety. Although this method is rational enough, it is not customary outside of France, because many of the materials we use, notably cast iron, and sometimes wrought iron and hard steels, have no definite elastic limit. In any case where the elastic limit is unknown or ill-defined, we arbitrarily assume it to be one-half the ultimate strength, and factor a becomes 2. For nickel-steel and oil-tempered forgings the elastic limit becomes two-thirds of the ultimate strength, or even more, and the factor is accordingly reduced to $1\frac{1}{2}$.

The second factor, b, appearing in our equation is one depending upon the character of the stress produced within the material. The experiments of Wohler, conducted by him between the years 1859 and 1870 at the instance of the Prussian government, on the effects of repeated stresses, confirmed a fact already well known, namely, that the repeated application of a load which would produce a stress less than the ultimate strength of a material would often rupture it. But they did more. They showed the exact relation between the variation of the load and the breaking strength of the material under that variation. The investigation was subsequently extended by Weyrauch to cover the entire possible range of variation. Out of the mass of experimental data so obtained a rather complicated formula was deduced, giving the relation between the variation of the load (or rather the stress it produced), the strength of the material under the given conditions (which is generally known as the "carrying strength" of the material) and the ultimate strength. To Prof. J. B. Johnson, I believe, is due the credit of substituting for this formula a much simpler and more manageable one, which perhaps represents the actual facts with almost equal accuracy. Prof. Johnson's formula is as follows:

$$f = \frac{U}{2 - \dfrac{p'}{p}}.$$

Where f is the "carrying strength" when the load varies repeatedly between a maximum value, p, and a minimum value, p'. U is the ultimate strength of the material. The quantities p and p' have plus signs when they represent loads producing tension and minus signs when they represent loads producing compression.

From what I have just said, it follows that if the load is variable in character, factor b must have a value,

$$b = \frac{U}{f} = 2 - \frac{p'}{p}.$$

Let us now see what this factor will be for the ordinary variations in loading.

Taking first a steady, or dead load, $p' = p$ and therefore $\frac{p'}{p} = \frac{1}{1} = 1$, and we have our factor,

$$b = 2 - \frac{p'}{p} = 2 - 1 = 1$$

In other words, this factor may be omitted for a dead load.

Taking a load varying between zero and a maximum,

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* Throughout this article we will adhere to the following definitions:

A "stress" is a force acting within a material, resisting a deforma-on.

A "load" is a force applied to a body, from without. It tends to :oduce a deformation, and is resisted by the stress which it creates ithin the body.

A "working load" is the maximum load occurring under ordinary orking conditions.

A "working stress" is the stress produced by the working load, static-ly applied.

The "safe working stress" is the maximum permissible working ress under the given conditions.

The "ultimate strength" of a material is its breaking strength in ounds per square inch, in tension, compression, or shearing, as the ise may be.

A "total stress" is the sum of all the stresses existing at any section a body.

Unless a stress is mentioned as a total stress, the number of pounds er square inch of section, sometimes called "the intensity of stress," ill be meant.

Forrest E. Cardullo was born in Buffalo, N. Y., 1879. After com-leting a high school course at Titusville, Pa., he attended Cornell niversity and received the degree of M. E. in 1901. He then served n apprenticeship with the Titusville Iron Co., and has since been nployed by the Osborne Engineering Co., Cleveland, The Engineer ublishing Co., Chicago, The Holly Mfg. Co., Buffalo, and the Snow team Pump Works, also of Buffalo. His positions have been those f draughtsman, machinist, and designer, and he is now engaged in eaching the subject of Machine Design at Syracuse University, yracuse. The class of work which he has specially devoted himself is high-power steam and gas engines and heavy machine tools. e is known to the readers of mechanical literature by his contribu-ons to the *Sibley Journal of Engineering* and *The Engineer*, and by is book on "The Principal Dimensions of Pumping Engines," which as come into use with pumping engine builders in preparing designs. he book has, as yet, been published and sold in blue print form only

$$\frac{p'}{p} = \frac{0}{p} = 0,$$

and we have for our factor,

$$b = 2 - \frac{p'}{p} = 2 - 0 = 2.$$

Again, taking a load that produces alternately a tension and a compression equal in amount,

$$p' = -p \quad \text{and} \quad \frac{p'}{p} = -1,$$

and we have, for our factor,

$$b = 2 - \frac{p'}{p} = 2 - (-1) = 2 + 1 = 3.$$

A fourth time, taking a load which produces alternately a tension and a compression, the former being three times the latter,

$$p = -3\,p' \quad \text{and} \quad \frac{p'}{p} = -\tfrac{1}{3}.$$

and we have for our factor,

$$b = 2 - \frac{p'}{p} = 2 - (-\tfrac{1}{3} = 2 + \tfrac{1}{3} = 2\tfrac{1}{3},$$

Recapitulating our results, we may say that when the load is uniform, factor $b = 1$; when it varies between zero and a maximum, factor $b = 2$; when it varies between equal and opposite values, factor $b = 3$; when the load varies between two values, p and p', of which p' is the lesser factor, $b = 2 - \frac{p'}{p}$. It may be noted that this factor becomes 1 for such cases as a steam boiler, or a railroad bridge, where the load varies between zero and a maximum for only a few thousand times at the most. In the case of a piston rod, however, where the variation will be repeated for hundreds of millions of times, the factor must be given the full value noted in the first part of this paragraph, and so for any similar conditions of service.

The experiments which have been made upon the effects of variable loads have almost without exception been made upon mild steel and wrought iron. Designers are in need of data based upon the results obtained with bronze, nickel steel, cast iron, etc. The explanation of this matter is generally believed to be as follows:

It has already been noted that a stress many times repeated will rupture a piece when that stress is greater than the elastic limit, but less than the ultimate strength. It is also known that the application of a stress will change the elastic limit of a material, often by a very considerable amount. A material has really two elastic limits, an upper and a lower one, the latter often being negative in value (*i.e.*, an elastic limit in compression). Between these two limits there is a range of stress, which we may call the elastic range of the material, and within which the material is, so far as we can discover, perfectly elastic. It has been assumed, therefore, that under the influence of the varying or repeated load, this elastic range takes on certain limiting values depending on the character of the variation. So long as the variation is confined within these limits, the piece is safe. If, however, the range of variation of the stress, exceeds the elastic range of the material under the given conditions, the piece breaks down. In confirmation of this view of the case, it has been found that pieces long subject to alternating stresses have an elastic limit of one-third their ultimate strength, while pieces subject to either repeated tensions or compressions only, have an elastic limit of one-half their ultimate strength.

From lack of data we cannot speak with authority in this matter, but it is probable that for material whose elastic limit is other than one-half its ultimate strength, Prof. Johnson's formula, and considerations derived from it, no longer hold. It is more than likely that with fuller knowledge of the subject we will find that the facts of the case may be more truly expressed by the formula,

$$f = \frac{n\,U}{1 - \frac{p'}{p}(1 - n)}$$

where n is the ratio of the elastic limit to the ultimate strength.

The third factor, c, entering into our equation, depends upon the manner in which the load is applied to the piece. A load suddenly applied to a machine member produces twice the stress within that member that the same load would produce if gradually applied. When the load is gradually applied, the stress in the member gradually increases, until finally, when the full load is applied, the total stress in the member corresponds to this full load. When, however, the load is suddenly applied, the stress is at first zero, but very swiftly increases. Since both the load and the stress act through whatever slight distance the piece yields, the product of the average total stress into this distance must equal the product of the load into this same distance. In order that the average stress should equal the load, it is necessary that the maximum value of the stress should equal twice the load. In recognition of this fact, we introduce the factor $c = 2$ into our equation when the load is suddenly applied.

It sometimes occurs that not all of the load is applied suddenly, in which case the factor 2 is reduced accordingly. If one-half the load were suddenly applied, the factor would be properly 1½, and in general, if a certain fraction of the load, $\frac{n}{m}$, is suddenly applied, the factor is $1 + \frac{n}{m}$. Or again, it may occur that friction, or some specially introduced provision, may prevent the sudden application of the load from having its full effect, in which case, if the amount of the reduction of this effect be known, or if it be possible to compute it, an appropriate reduction may be made in the value of this factor.

Sometimes, however, a load is applied not only suddenly, but with impact. In such a case, it is highly desirable to compute the total stress produced by the load, and to substitute it for the load when obtaining the working section. Failing in this, it is necessary to make factor c more than 2, and sometimes as high as 10 or more. As an example of the possibilities arising in ordinary work, I may instance an elevator suspended by a wire rope of one square inch in section, and fifty feet long. If a truck weighing 500 pounds were wheeled over the threshold and allowed to drop two inches onto the elevator platform, a stress of over 10,000 pounds would be produced in the rope. Thus we see that in this very ordinary case arising in elevator service, this factor would need to be as much as 20.

The last factor, d, in our equation, we might call the "factor of ignorance." All the other factors have provided against known contingencies; this provides against the unknown. It commonly varies in value between 1½ and 3, although occasionally it becomes as great as 10. It provides against excessive or accidental overload, against unexpectedly severe service, against unreliable or imperfect materials, and against all unforeseen contingencies of manufacture or operation.

When we can compute the load exactly, when we know what kind of a load it will be, steady or variable, impulsive or gradual in its application, when we know that this load will not be likely to be increased, that our material is reliable, that failure will not result disastrously, or even that our piece for some reason must be small or light, this factor will be reduced to its lowest limit, 1½.

The conditions of service in some degree determine this factor. When a machine is to be placed in the hands of ignorant or unskilled labor, when it is to receive hard knocks or rough treatment, the factor must be made larger. When it will be profitable to overload a machine by increasing its work or its speed in such a way as to throw unusual strains upon it we are obliged to discount the probability of this being done by increasing this factor. Or again, when life or property would be endangered by the failure of the piece we are designing, this factor must be made larger in recognition of the fact. Thus, while it is 1½ to 2 in most ordinary steel constructions it is rarely less than 2½ for a better grade of steel in a boiler Even if property were not in danger of destruction, and the failure of the piece would simply result in considerable loss in output or wages, as in the case of the stoppage of a factory it is best to increase this factor somewhat.

The reliability of the material in a great measure deter-

mines the value of this factor. For instance, in all cases where it would be 1½ for mild steel, it is made 2 for cast iron. It will be larger in those materials subject to internal strains, for instance complicated castings, heavy forgings, hardened steel, and the like. It will be larger for those materials more easily injured by improper and unskillful handling, unless we know that the work will be done by skilled and careful workmen. It will be larger for those materials subject to hidden defects, such as internal flaws in forgings, spongy places in castings, etc. It will be smaller for ductile and larger for brittle materials. It will be smaller as we are sure that our piece has received uniform treatment, and as the tests we have give more uniform results and more accurate indications of the real strength and quality of the piece itself.

Of all these factors that we have been considering, the last one alone has an element of chance or judgment in it, except when we make an allowance for shock. In fixing it, the designer must depend on his judgment, guided by the general rules I have here attempted to lay down.

Some of my readers may ask at this point, why, if we introduce a factor for the elastic limit, do we also introduce a factor for repeated loads? They will argue that if we keep the stress within the elastic limit, no harm will be done, no matter how often the load be repeated, and they are right. However, with a dead load acting upon a piece and straining it to its elastic limit, we have as a margin of safety the difference between its elastic limit and its ultimate strength. But when the load is a repeated load, of the same amount as before, the piece has no margin of safety, unless its section be increased, and it does not have the same margin of safety as it had in the first place, until its section is doubled.

It remains to illustrate the method I have outlined for developing an "apparent factor of safety" by some practical examples. Let us take first the piston rod of a steam engine. It will be of forged steel, of simple form and reasonable size. The elastic limit will presumably be slightly more than one-half the ultimate strength, so factor $a = 2$. The rod will be in alternate tension and compression many times a minute and factor $b = 3$. The steam pressure will be applied suddenly (in a great many engines, on account of compression, only a part of this load is applied suddenly) and factor $c = 2$. And since the material is reliable, and the service definite and not excessively severe, factor $d = 1\frac{1}{2}$. Then,

$$F = 2 \times 3 \times 2 \times 1\tfrac{1}{2} = 18.$$

Taking next a steam boiler, our factor $a = 2$ as before. Since the load is steady and gradually applied, factor $b = 1$ and factor $c = 1$. Although we have an exceptionally reliable material, corrosion is likely to occur, and failure would be disastrous to life and property, so factor $d = 2\frac{1}{2}$ or 3, depending upon the workmanship.

Then $F = 2 \times 1 \times 1 \times 2\frac{1}{2}$ (or 3) $= 5$ (or 6).

For our last illustration we will take the rim of a castiron flywheel for a steam engine. Factor $a = 2$, factor $b = 1$, and factor $c = 1$, for the load which is due to centrifugal force is constant. However, the material is the most unreliable with which the designer has to deal. It is probably spongy, and has great internal stress resulting from the cooling. It would be easy and profitable to increase both the power of the engine and the strain in the rim, by speeding it up. In ordinary cases we would make factor d equal to 3 or 4, but in this case the stress in the rim increases, not with the speed, but with the square of the speed, and it is entirely proper to make factor $d = 10$. So we have

$$F = 2 \times 1 \times 1 \times 10 = 20.$$

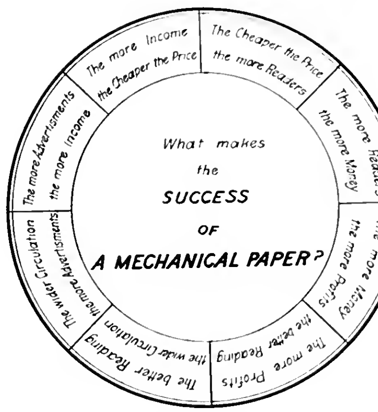
The following table may be helpful in assisting the designer to a proper choice of the factor of safety. It shows the value of the four factors for various materials and conditions of service, and will give helpful hints to the young designers as to what factors to use under similar circumstances.

CLASS OF SERVICE OR MATERIALS.	Factor a	b	c	d	F
Boilers	2	1	1	2¼-3	4½- 6
Piston and connecting rods for double-acting engines..	1½-2	3	2	1½	13½-18
Piston and connecting rod for single-acting engines..	1½-2	2	2	1½	9 -12
Shaft carrying bandwheel, flywheel, or armature.....	1½-2	3	1	1½	6¾- 9
Lathe spindles	2	2	2	1½	12
Mill shafting	2	3	2	2	24
Steel work in buildings	2	1	1	2	4
Steel work in bridges.......	2	1	1	2½	5
Steel work for small work...	2	1	2	1½	6
Cast iron wheel rims.......	2	1	1	10	20
Steel wheel rims............	2	1	1	1	8
MATERIALS	Minimum Values.				
Cast iron and other castings.	2	1	1	2	4
Wrought iron or mild steel..	2	1	1	1½	3
Oil tempered or nickel steel.	1½	1	1	1½	2¼
Hardened steel	1½	1	1	2	3
Bronze and brass, rolled or forged	2	1	1	1½	3

* * *

A JOURNALISTIC ROUND ROBIN.

An occasional correspondent, Mr. Edward W. Chodzko, of Haiphong-Tonkin, China, has been making a long distance telescopic study of the trade paper problem and has sent us a sketch embodying the conclusions derived from his investigations. We are not sure that the cut has been made right side



up, as a prolonged contemplation of the copy induces a feeling of dizziness, rendering it inadvisable to investigate the matter too closely The idea which underlies the diagram is very evident, and on the whole it is a good way of expressing the relation of the various factors which influence the development of a growing technical journal.

* * *

FRICTION GEARING.

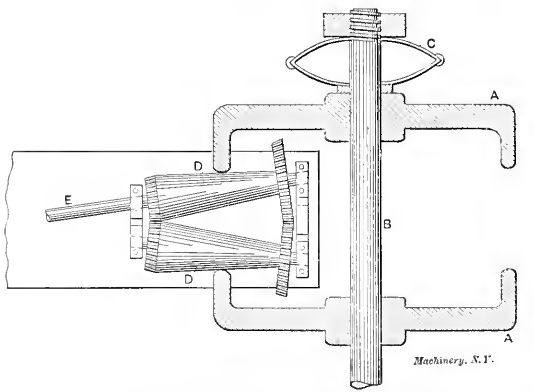
Perhaps there is no form of power transmission at which designers look askance more than the so-called friction wheel gearing, and the disfavor with which it is viewed is apparently well merited in view of the inefficiency of most forms of friction wheel drive. But there are two sides to the question and when we look at it broadly it becomes evident that the usual defect of the friction drive, slipping, is not essentially fundamental. For example, we have but to look at the locomotive, which is the most common example of power transmission by the mere friction of smooth surfaces, *i. e.*, the drivers and track. The efficiency of the locomotive as a friction wheel power transmitter lies largely in the fact that the coefficient is chosen well within the limits which mark average working conditions. The extreme coefficient is usually taken at 24 or 25 per cent. That is, the drivers will give a tractive power equal to about one-fourth the weight they carry before they begin to slip. For example, if the weight carried by four drivers is 80,000 pounds the maximum tractive force can be figured as being about 20,000 pounds. This figure, however, is too high with certain conditions of rail, hence the sandbox as a corrective. If now, a friction drive of the stationary type is so designed that the power transmission required comes within a coefficient limit, say, of 10 or 12 per cent, it is quite plain that such a drive must always operate, provided that constant pressure is maintained between the driving and driven wheels sufficient to balance the required torque with the friction coefficient named. The reason that it must always drive without slipping is that the coefficient of 10 or 12 per cent is less than that of poorly lubricated surfaces, and should

TABLE SHOWING NUMBER OF PIECES IN ONE POUND WHEN WEIGHT OF ONE HUNDRED PIECES IS GIVEN.

Pounds.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Oz.		100.00	50.00	33.33	25.00	20.00	16.67	14.29	12.50	11.11	10.00	9.09	8.33	7.69	7.14	6.66	6.25	5.88	5.56	5.26	5.00	4.76	4.54	4.35	4.16	4.00
1	1600.00	94.12	48.48	32.65	24.61	19.75	16.49	14.16	12.40	11.03	9.94	9.04	8.29	7.65	7.11	6.64	6.23	5.86	5.54	5.24	4.98	4.74	4.53	4.34	4.15	3.99
2	800.00	88.88	47.06	32.00	24.24	19.51	16.33	14.03	12.31	10.96	9.88	8.99	8.25	7.62	7.08	6.61	6.20	5.84	5.52	5.23	4.96	4.73	4.52	4.33	4.14	3.98
3	533.33	84.21	45.71	31.37	23.88	19.27	16.16	13.91	12.21	10.89	9.82	8.94	8.20	7.58	7.04	6.59	6.17	5.82	5.50	5.21	4.95	4.71	4.51	4.32	4.13	3.97
4	400.00	80.00	44.44	30.77	23.52	19.05	16.00	13.79	12.12	10.81	9.76	8.89	8.16	7.54	7.01	6.56	6.15	5.80	5.48	5.19	4.94	4.70	4.50	4.30	4.12	3.96
5	320.00	76.19	43.24	30.19	23.19	18.82	15.84	13.67	12.03	10.74	9.69	8.84	8.12	7.51	6.98	6.53	6.13	5.78	5.46	5.18	4.92	4.69	4.49	4.29	4.11	3.95
6	266.66	72.73	42.11	29.63	22.86	18.60	15.69	13.56	11.94	10.67	9.64	8.79	8.08	7.47	6.95	6.50	6.11	5.76	5.44	5.16	4.90	4.68	4.48	4.28	4.10	3.94
7	228.57	69.57	41.03	29.09	22.53	18.39	15.53	13.44	11.85	10.59	9.58	8.74	8.04	7.44	6.92	6.47	6.08	5.74	5.42	5.14	4.89	4.66	4.46	4.27	4.09	3.93
8	200.00	66.67	40.00	28.57	22.22	18.18	15.38	13.33	11.76	10.53	9.52	8.69	8.00	7.41	6.89	6.45	6.06	5.72	5.40	5.12	4.88	4.65	4.44	4.25	4.08	3.92
9	177.78	64.00	39.02	28.07	21.92	17.98	15.24	13.22	11.68	10.46	9.47	8.65	7.96	7.37	6.86	6.43	6.04	5.70	5.38	5.11	4.86	4.64	4.43	4.24	4.07	3.91
10	160.00	61.54	38.09	27.58	21.62	17.78	15.09	13.11	11.59	10.39	9.41	8.60	7.92	7.34	6.84	6.40	6.01	5.68	5.36	5.09	4.84	4.63	4.42	4.23	4.06	3.90
11	145.45	59.26	37.21	27.12	21.33	17.58	14.95	13.01	11.51	10.32	9.36	8.56	7.88	7.31	6.81	6.37	5.98	5.66	5.34	5.08	4.83	4.61	4.41	4.22	4.05	3.89
12	133.33	57.14	36.36	26.67	21.05	17.39	14.81	12.90	11.43	10.25	9.30	8.51	7.84	7.27	6.78	6.35	5.96	5.64	5.32	5.07	4.82	4.60	4.39	4.21	4.04	3.88
13	123.08	55.17	35.56	26.23	20.78	17.20	14.68	12.80	11.35	10.19	9.25	8.46	7.80	7.24	6.75	6.32	5.94	5.62	5.31	5.05	4.81	4.59	4.38	4.19	4.03	3.87
14	114.29	53.33	34.78	25.81	20.51	17.02	14.54	12.70	11.27	10.13	9.19	8.42	7.76	7.21	6.72	6.30	5.92	5.60	5.30	5.04	4.79	4.57	4.37	4.18	4.02	3.86
15	106.67	51.61	34.04	25.40	20.25	16.84	14.41	12.60	11.19	10.06	9.14	8.38	7.73	7.17	6.69	6.27	5.90	5.58	5.28	5.02	4.78	4.56	4.36	4.17	4.01	3.85

the working surfaces become greasy they must still continue to transmit power, nevertheless.

The difficulty with this proposition lies in the fact that with the usual design a large percentage of the power transmitted



An Example of Friction Gearing without Frictional Reaction.

is absorbed in journal friction. For example, suppose that we have two friction wheels 20 inches in diameter. They are required to transmit a torque of 100 pounds measured at the periphery. With the coefficient of 10 per cent this means that the wheels must be held together with a force of at least 1,000 pounds. This pressure of 1,000 pounds reacts upon the journals and if the journals are say 2 inches in diameter it means that practically one-fifth or 20 per cent of the power transmitted will be absorbed in journal friction under average conditions. This is very objectionable, not only because of a loss of power, but because of the trouble due to journal heating which is almost sure to result when any large amount of power is to be transmitted. But if the designer bears in mind the fact that the force required to produce traction may be balanced and in that way he can relieve the bearings of unnecessary load, a long step is taken in advance. To illustrate the idea, we present herewith a cut taken from a specification of a patent granted to Mr. A. Robinson in 1889, No. 406,477. The principle shown is so evident that little explanation is necessary. The shaft *B* carries two disks, *A A*, one of which is tightly secured to the shaft, and the other is loosely keyed thereon so that the spring *C* is free to move it longitudinally. Between these disks are the friction rollers *D D* to which motion is transmitted. The two friction rollers carry the load due to the pressure of the spring *C* but that pressure is not transmitted to the journals of *D D*, being instead carried by surfaces in rolling contact. Hence, there is a total absence of excessive journal pressure and all the pressure produced by the spring *C* is absorbed in producing adhesion between disks *A A* and the rollers *D D*. This device is also a variable speed mechanism and one which apparently is meritorious.

* * *

TABLE SHOWING NUMBER OF PIECES IN ONE POUND WHEN WEIGHT OF ONE HUNDRED PIECES IS GIVEN.

The accompanying table shows the number of pieces in one pound when the weight of 100 pieces is known. It should be convenient oftentimes, especially in the stock-room when inventory is being taken. To illustrate its use find, for example, the number of pieces in one pound when 100 pieces weigh 5 pounds 9 ounces: The number in one pound is found by starting at "9" in the column headed "oz" and tracing to the right until underneath "5," where the number of pieces in one pound is found to be 17.98. The table was compiled by Mr. A. L. Kline, Chicago, Ill.

* * *

THE JANUARY DATA SHEET.

The material for this month's data sheet was contributed by Mr. R. F. Kiefer, of Sharon, Pa. Diagrams and tables are given to facilitate the computation of stresses in the members of the usual forms of roof trusses.

AN EXPERIMENT IN INDUSTRIAL EDUCATION.

O. M. BECKER.

As an illustration of the practical workings of factory education it may be worth while to describe the educational activities at a typical American industrial plant, the McCormick Works of the International Harvester Company, Chicago. The educational system in this factory, except the so-called "kindergarten" for apprentices, is very recent and by no means fully developed as yet. Indeed it is quite evident that the problem is yet scarcely touched.

The two forms of factory education, the one designed to develop technical skill and the other to raise the social and intellectual level of the employed, are carried on together. For a number of years it has been the practice to select from among the boys throughout the plant the most promising, and to place these in one of the tool room departments, the foreman of which was expected to give them somewhat more than the usual amount of supervision, and some instruction. The wages paid boys in his "kindergarten," as it has come to be called throughout the plant, are less than most of them are able to earn at piecework. There is, nevertheless, always a full quota in this class, and usually a number of boys on the waiting list. There is no apprenticeship contract, and indeed no systematic effort to give instruction, other than that which the boys get incidentally. It is, in fact, merely the old apprenticeship system, with the indentures omitted. No particular time is fixed during which the apprentices continue as such. They work along, most of them receiving increases in pay from year to year, and in course of time find themselves working among the older machinists and receiving average machinist's pay. The arrangement works very well, but like the old apprenticeship system, is wasteful of the apprentice's time, and therefore economically inefficient.

About two years since classes were formed in mechanical drawing, which were open to all employees, and which the "kindergartners" were encouraged to attend. There was an immediate response to the invitation, and very soon additional classes were opened. At first the classes met two evenings a week in rooms used for other purposes during the day. A small charge was made, not with the idea of covering the expense of the class, but rather to promote a feeling of independence in the students. They were not getting something for nothing, but like honest and independent men were paying the price for it.

The origin of these classes is itself interesting, and suggestive as a study in evolution. For some time a social settlement near the works had been encouraging the formation of various classes of neighborhood boys, and among others one for instruction in mechanical drawing was started. The instructor happened to be the chief draftsman at the McCormick Works, and the students were mainly employees in the same place. The classes increased in size and number, and came to the notice of the company officials through a contribution of suitable drawing tables which they made to the settlement. The officials became interested in the classes, and some time afterward approved the opening of similar ones in connection with the works.

So much interest was taken in mechanical drawing that classes in other subjects also were organized, on the same conditions; namely, evening meetings and a nominal fee, but open to everybody. All these were well patronized, not only by employees of the company, but by others in the neighborhood—some students even coming from remote parts of the city.

The educational scheme, as pointed out, was not thoroughly organized at this time, the purpose being not to start out with a full-fledged educational system, but rather to allow one to develop along lines of least resistance, adjusting itself to the needs and wants of its constituency as they became apparent. Under the superintendence of a thoroughly trained school man, experienced in administration, technical teaching, and for several years in close touch with the industrial situation through his employment in a large factory, the educational activities were planned without especial reference to their logical correlation, but rather with a view to encouraging employees of differing tastes and needs to become interested. The technical school offers to open a class in any subject in which a reasonable number, say five, will enroll and pay the fee, usually two dollars for a term of ten weeks or forty hours. In a few courses the fee is only one dollar a term.

Under this arrangement classes are maintained in Arithmetic (three), Domestic Science, English (two), Machine Demonstration, Machinery, Mechanical Drawing (three), Sewing, Shorthand and Typewriting, Penmanship and Manual Training or Woodwork. The number of students in each varies from five to more than a hundred. Some of the classes beginning work last fall continued throughout the three terms of the year to follow progressive courses in their respective subjects. In fact all but one or two did so last season. For each subject a course covering at least three terms of ten weeks (forty hours) each is mapped out. Some of the courses, as Mechanical Drawing and Machinery, for instance, cover

Fig. 1 The McCormick Technical School.

longer periods. The interest in the educational work is strikingly manifested by the large registrations and continued attendance, as well as the wide diversity in age and attainment of students. A majority of these are naturally young men and boys, a few as young as thirteen. There is, however, a liberal sprinkling of men, occasionally one past the half century mark.

The courses mapped out are intended to be intensely practical, those in the technical subjects especially being planned with the needs and experiences of the mercantile shop always in mind. For instance, in the drafting classes, the students learn to draw almost from the beginning the things with which they are familiar in the shops, and learn the practical methods of the big drafting room. In the machinery class, carried on in one of the large tool rooms of the plant, they turn out commercial work, such as is done on the same machines during the day by the machinists employed there. Furthermore, the instructors (each of the drawing classes has one, and the machinery class has two) are men who are themselves employed in the plant and thoroughly familiar with shop methods and practices. This alone would not suffice to make the instruction of a high order. But the men selected for leading the classes are also skillful and imbued with the teaching spirit.

The Machine Demonstration class deserves special mention, for so far as is known to the writer it is unique in purpose and method. A few concerns undertake to teach salesmen and repairmen the nature and structure of the machines they deal in. The class mentioned is open to all employees, but is designed especially for office men who constantly talk about and deal in machines and parts with which they are wholly unfamiliar except as to the name or designation. The man in charge of the class, a man who knows more about all the machines manufactured in the plant than anybody else does about any one of them, illustrates his lectures with the machines and parts themselves, erecting and dissecting them before, or rather in the midst of his class. The clerk who daily handles K451 in his reports comes to have a greater interest in his work because he realizes the significance of the piece as part of useful whole, as a result of his attendance upon the lectures.

The courses in English and other non-technical subjects are not directly correlated with the technical subjects. The drawing, machinery, and certain mathematics, are related, and students in one course are encouraged to take, and many do take, one or more of the others. The idea is to give in about two years time a course in machinery, drawing and mathematics that will be a pretty good substitute for the usual apprenticeship, particularly when supplemented by practice in the shops, as it usually is. One of the English classes is especially interesting. It is composed mainly of foreign speaking men who at the beginning of the course are able to speak little if any English. To bring this class to the attention of as great a number as possible of the employees who might be benefited by it, a circular letter calling attention to it, written in the simplest possible English without being childish, is from time to time given out in selected departments. The response is reasonably satisfactory.

Since many girls are employed about the works, it is the desire to make some provision for them also in the technical school courses. Classes in Cookery and Housekeeping, and in Sewing are well patronized. Heretofore the first-named class has been using one of the kitchens connected with the works' dining room as a class room; and the other has been meeting in one of the Rest Rooms for Girls. Next fall, when the classes reopen they will meet in "The Cottage," a typical workingman's cottage fitted up simply but tastefully as a sort of neighborhood house for the women. It will doubtless also be used for other classes of women and children, should there be occasion to organize such.

The men's and boys' classes have been meeting, since its completion, in the new club house near the plant, a building designed in part for this purpose. The class rooms are all that could be desired, but are equipped and fitted in such a way as to suppress as much as possible the usual schoolroom air. The library and reading room in this building is a valuable adjunct to the school activities.

The instructors in the Technical School are largely men employed in the works, and are selected because of their special knowledge in their respective subjects and skill in presenting them. They are on this account probably better fitted for their work than the teachers in most engineering, techni-

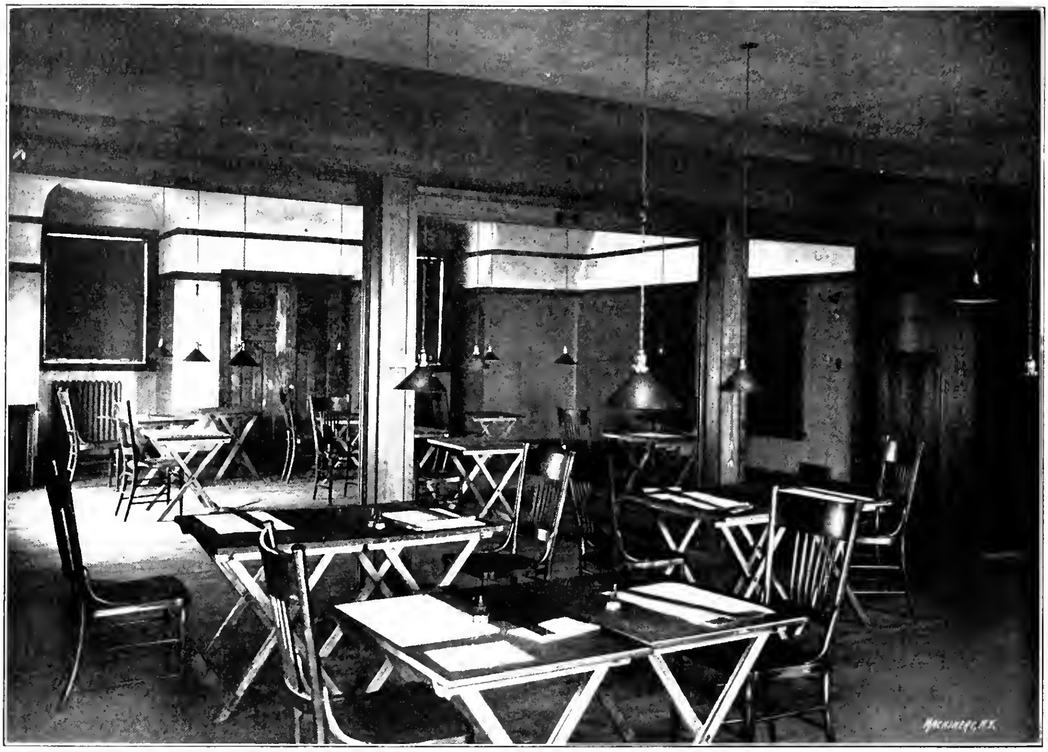


Fig. 2. Class Room for Instruction in Mechanical Drawing.

cal, or industrial schools, who usually have little or no practical shop experience and are, therefore, unacquainted with the actual conditions under which commercial work must be done. Some of the instructors in the school, however, are professional teachers or specialists employed elsewhere during the day. All are paid for their services.

A feature that is only indirectly educational is in connection with the use of the Chicago Public Library. Arrangements have been made so that any employee can take books, his library card being guaranteed by the company. The books are delivered to the workman's bench, and he is relieved of practically all care in taking and returning books further than to make selections of numbers from the finding lists and catalogues. This, however, is no small task for those of small acquaintance with book titles, and selections frequently turn out to be anything but pleasing. To help matters somewhat a number of lists of titles carefully selected as representative of the interests of young people and at the same time worthy of lasting place in literature have been printed and are at intervals distributed in such a way that a new list goes out each time to each reader, without great embarrassment to the library. The result has been unexpectedly satisfactory. There is much more reading than formerly, and in the main the reading is of a higher order.

No account of the educational activities at the McCormick works would be complete without a mention of how they began. For several years certain officials of the company had been greatly interesed in the problem of factory education, and had a number of times proposed to make a beginning in this direction. Finally, some two years ago, the new factory law came into effect, limiting to eight hours the labor of children between the ages of fourteen and sixteen. There were at the time a few, possibly fifteen, boys employed that were affected. Authority was given to organize these into a class, to meet during the first two hours of the day, under the instruction of an employee that had been a successful teacher. No particular course was marked out, the boys varying in attainment from graduates of the elementary school to those without any schooling. The general plan was to give as much individual instruction as possible in those things each boy seemed most deficient in. There were exercises in speaking and writing English, and much drill in arithmetic, nearly all of it developed with reference to the daily work and lives of the pupils. Occasionally, also, there were talks, by foremen and others, upon subjects in which especial interest had been manifested. One of the most interesting was a series of talks descriptive of his travels by a shop hand who had been about the world a good deal.

For one reason and another, chiefly because of no other boys of the limited age being employed and those in the class gradually leaving the employment of the company or passing the sixteen-year mark, the number was considerably reduced, and finally the class was closed, temporarily, as it was thought. The purpose, approved by the company officials, was to extend the little school gradually so as to take in all boys in the factory who cared to avail themselves of the privilege, allowing them certain hours weekly on company time for that purpose. A change in administration for the time being put the project in the background, and the need for it has been in part obviated by the more recent development of the McCormick Technical School. The logical evolution of the latter will doubtless again bring to the front the problem of getting at the boy who does not realize strongly his need for intellectual or technical training, and who with such training would become a much more efficient worker and better citizen. There is no reason to suppose that at the proper time the company will not again stand ready to extend the educational scheme to include just such instruction, on company time, as will make it possible to interest that class of boys, the boys who need most to be interested.

Though manifestly imperfect and inadequate as yet to the solution of the problem, the McCormick Technical School is nevertheless interesting as a successful experiment as far as it goes. It may point out, perhaps, the directions in which we may expect factory education to develop, for some time to come at any rate.

REPRESENTATIVE AMERICAN MECHANICS.

AMOS WHITNEY.

Amos Whitney was born in Biddeford, Maine, October 8, 1832. He served an apprenticeship with the Essex Machine Co., of Lawrence, Mass., beginning work at the age of 13. During his apprenticeship period of three years he worked on machinists' tools and locomotives, and after completing his apprenticeship, he stayed with the concern one year longer as a journeyman, working on cotton machinery. From Lawrence he went to Hartford, Conn., in 1850, to work in Colt's Armory. In 1852, F. A. Pratt came to Colt's, and there the future partners first became acquainted. In 1854 Mr. Pratt became superintendent for Geo. S. Lincoln & Co., afterwards known as the Phœnix Iron Works. Mr. Whitney went with him, and in 1860 he and Mr. Pratt started a little shop on Potter Street

Amos Whitney.

for making spoolers, both partners retaining their positions, working nights in their own shop. In 1862 Monroe Stannard, of New Britain, was taken into partnership, each partner putting into the business a capital of $1,200. This relationship continued until 1864, Mr. Pratt retaining his position as superintendent of the Phœnix Iron Works, and Mr. Whitney working there as a contractor. Incidentally it might be mentioned that it was while with this concern that Mr. Pratt designed the famous Lincoln miller. In 1864 both partners withdrew from the Phœnix Iron Works and gave all their time and attention to their own venture, building the first shop on the present location in 1865. From that time on, the history of Mr. Whitney is identified with that of the Pratt & Whitney Co., up to the time the business was sold to the Niles-Bement-Pond Co. in 1902.

From the beginning Pratt & Whitney machinery and tools were noted for fine quality and efficiency and within a few years they gained a world-wide reputation. Mr. Whitney is still (at the age of 73) a remarkably energetic man and possesses great endurance. For many years he was the principal salesman and also superintendent of the shops, sometimes having in his employ nearly 1,200 men. His ability to sell machinery and tools was not less marked than of keeping track of the work in the shop while away. On his return from business trips varying from two to eight weeks he would seem to know just how machinery being built on orders should have pregressed, and could take up the broken thread as if he had been continuously in the shop.

For a period of 30 years he traveled about one third of the time, visiting factories large and small throughout the principal manufacturing districts of the United States. His acquaintance was very large with the owners and their superintendents and foremen, and he enjoyed an enviable reputationtion for good judgment and reliability with them. He was often called upon to give advice with regard to machinery

for increasing product and reducing costs and many orders resulted which were of great benefit to the customers. In some cases he was given *carte blanche* to go ahead and build new machinery for a plant on his own responsibility, and with such orders he took great care to handle the work to the advantage of the purchaser. This popularity with large concerns had its drawbacks, for it led to the building of a great variety of machinery, much of which was of a special nature, on which no direct profit was made, as the cost often exceeded the figure which Mr. Whitney believed the customer could appreciate.

It was always Mr. Whitney's policy to keep close to the workmen, and visiting mechanics who desired the privilege of going through the shop were rarely denied. In fact, he often gave his own time in showing them about, and explaining machinery and methods of manufacture. Needless to say, this was missionary work of the most valuable kind, for in after years some of these men came to have positions of responsibility, and the methods they saw used in the manufacture of Pratt & Whitney machines, naturally inclined them to purchase from that concern when they wanted a first-class product.

In 1871 and 1872, after the close of the Franco-Prussian war, the Pratt & Whitney Co. received from the German government orders for gun machinery to equip three royal armories amounting to $1,450,000. Another work which gave the concern great prestige was the development of the standard plugs and gages, and this was brought about largely by the confusion that existed in screw thread sizes. In the early seventies they were building a line of bolt-threaders, largely used in railroad shops, but there was such a great variety of screw sizes and leads of thread that it was practically impossible to carry a stock that would meet the requirements of different shops. An inch bolt might be almost any size except one inch diameter. It might be 1-64 inch over or under the size, and might have a half-dozen different leads of thread. The establishment of standard sizes led up to the adoption of the U. S. or Sellers standard screw threads now in general use. The first set of standard P. & W. plugs and gages to be publicly exhibited was shown at the Centennial Exposition in Philadelphia in 1876. In this connection Mr. Whitney tells of an interesting discovery, which although now well-known, had not hitherto been realized. The plugs and gages for the exposition were made with the utmost refinement and were ready some weeks before its opening. Just before sending them they were tested, and to the astonishment of all concerned, it was found that they could not pass the crucial test required. They were refitted and sent to Philadelphia, and after receipt there were again tested and strangely enough were again found to be out of truth. It was then demonstrated, perhaps for the first time, that tool steel in any shape changes for a long time after being hardened and requires "seasoning" before it can safely be finished to exact size.

In 1893 the Pratt & Whitney Co. sold their business to a syndicate of New York bankers but Mr. Whitney retained his connection with the firm as superintendent and vice-president up to 1898, and then became president, retaining this position until the absorption of the business by the Niles-Bement-Pond Co., whereupon Mr. Whitney retired from active business.

He is now a director in several important Hartford enterprises and is treasurer of the Whitney Mfg. Co., which was organized in 1896, and is at present owned by him and his son, C. E. Whitney.

The accompanying photograph was taken in 1900 on the fiftieth anniversary of the date when he came to Hartford. He spent the day visiting the various places in Hartford where he had worked, and renewing old acquaintances and memories.

* * *

The manufacture of wrought iron tubes was commenced in this country some time between 1830 and 1834 by the firm of Morris, Tasker & Morris, according to the statement of Mr. Henry G. Morris in an article on the subject appearing in the October issue of the *Valve World*. A small welding furnace was built in the cellar of the shop at Third and Walnut Streets in Philadelphia and William Griffiths, a pipe welder from England, was hired to make the first pipe.

THE DRAWING OF CARTRIDGE-CASES FOR QUICK-FIRING GUNS.*

The development of the quick-firing gun has at once necessitated, and been rendered possible, by improvements in ammunition with a view to quick loading. Quick-firing guns differ from ordinary guns in having the propelling charge and the means of ignition contained in a metal case. The projectile may or may not be attached to the case, forming a complete cartridge, as this depends on the size of the gun. In ordinary guns the projectile, the propelling charge, and the primer or means of ignition, are all separate, the charge being usually contained in a combustible silk cloth or serge case. The advantages which metal cases present as compared with combustible cases are: (1) They are quicker in loading, since the primer forms an integral part. (2) The same reason reduces the probability of a miss-fire. (3) The sponging-out of the gun, to avoid the possibility of the burning remnant of a combustible case prematurely igniting the next charge, is avoided. (4) The expansion of a brass case under fire enables it to act as a gas-check, rendering the use of an obturator unnecessary.

Simultaneous loading with "fixed" ammunition, in which the projectile is attached to the cartridge case, is practiced with quick-firing guns up to about 3 inches diameter, above which size complete cartridges would be too unwieldy. Between 3 inches and 6 inches, therefore, separate loading is the rule, with the projectile separate from metallic cartridge case. Above 6 inches the gun ceases to be called quick-firing, and combustible cases with separate loading are used. Separate loading for larger quick-firing guns is desirable, not only because of the excessive weight of a complete cartridge, but also because of the danger of storing loaded and fused shell in the same magazine with loaded cases. With separate loading, the projectile may be placed near the gun at leisure, the cartridge-cases not being taken from store until the last moment. Such different conditions govern the storage, transport, and use of projectiles and of cartridge-cases that it is undesirable to attach them together.

Cartridge-cases for quick-firing guns are universally made of brass, this material having been found to possess the qualities best suited for this exacting service. Of all the numerous alloys that of copper and zinc, commonly called brass, ranks as one of the most important. At one period the generic name of bronze was given to this alloy as well as to that of copper and tin, to which it is now applied. The two alloys, copper-tin and copper-zinc are each characterized by well-defined properties, and each should retain its proper name of brass and bronze respectively. No other metal or alloy, not even excepting iron, presents such widely varying qualities, or so great a field of application. Commercial brass consists of two parts of copper and one of zinc, and is used, with certain exceptions, in all countries for cartridge-cases, not only for rifles but for quick-firing guns. The exact composition is 67 per cent of copper and 33 per cent of zinc, with a margin of 5 per cent above or below for either metal. The French artillery department, which is noted for the care with which its specifications for cartridge-case metal are drawn up, not only specifies the above-named proportion and variation, but requires that the constituent metals shall be of accepted brands, and of known origin, the sources of supply of copper being limited to the following: "Calumet and Hecla," "Tamerack," "Ovscila," "Atlanta," "Franklin," "Quincy," "Wallaroo," and that manufactured by electrolytic deposition. The brands of zinc specified are: "Vieille Montagne," known as "Extra Pure Fonte d'Art," "Oeschger Mesdach," "O.M. Art Zinc," and that of the Royal Austrian Company of Spain, known as the "R. C. A. Refinado." Subject to certain limitations, the use of scrap brass is also allowed.

The entire manufacture of metallic cartridge-cases involves a series of operations which, with the exception of two or three, consist in cold-drawing. The brass used is capable of extreme deformation when cold, but cannot be worked hot. After being formed into a cup-shaped disk, the metal is subjected to successive drawings, the object of which is to diminish the diameter and thickness and increase the length, the volume undergoing no sensible alteration. At each draw-

* Abstract of Paper by Col. Leandro Cubillo of Trubia, Spain, and Mr. Archibald Head of London, before the Institution of Mechanical Engineers, October 2, 1905.

ing the metal is deformed to a point short of the breaking point, every drawing operation being followed by annealing until the desired form is obtained, namely, a long cylinder with thin walls, and closed at one end.

The earlier operations, while the cartridge-case is still short, are carried out in a vertical press, but when the length is such that the manipulation and the withdawal of the punch become difficult, the operation is continued in horizontal presses. The two most important tools are the punch and the die. The punch is carried upon the extremity of the ram of the press and transmits the power, acting upon the bottom of the cartridge-case, which is inserted in the larger end of the die, the latter being strongly secured to the head of the press opposite the hydraulic cylinder. The die consists of a ring of hardened and tempered steel, the interior having the shape of a truncated cone, the axis of which is in a straight line with that of the punch. The operation of drawing is performed by placing a partly-drawn case, properly centered, in the larger end of the die, and advancing the punch until it touches the bottom of the cup. The pressure then comes into play, forcing the cup through the small end of the die, thereby reducing the diameter of the cup and the thickness of the walls and increasing the length, a process which involves considerable flow of metal.

During the process of drawing, the cartridge-case is subjected to stresses in general oblique to the surface, represented by P (in the stress diagram in Fig. 1). This stress may be resolved into two, one of which is normal and the other tangential to the surface of contact between the brass and the die, called respectively N and T. If E represents the total pressure exerted by the punch upon the bottom of the cartridge-case, it is clear that equilibrium will exist when the vertical components of the normal and tangential forces are together equal and opposite to the force E. If a is the angle formed by the wall of the die with the axis of the punch, the equation of equilibrium will be: $E - T \cos a - N \sin a = 0$. Thus it will be seen that the forces N and T vary with the magnitude of the angle a. As this increases $\sin a$ increases and $\cos a$ diminishes, and consequently the values of the components T and N also decrease and increase respectively. When $a = 90$ deg. $\sin a = 1$, and $\cos a = 0$, and E is then equal to N. When $a = 0$ then $\sin a = 0$ and $\cos a = 1$, E being equal to T. In the first case this stress would be entirely normal, and in the second case entirely tangential and tensile. The two extreme cases, however, never occur. In practice the flow of the metal is never achieved by simple tensile forces, and compressive forces are always present. The drawing of a 6-inch cartridge-case will now be described in detail:

Cupping.—The cupping is divided for convenience into two stages, the first being done with the punch and die illustrated in Fig. 2. Before commencing it is necessary to center the die relatively to the punch, the breadth of the annulus being measured at three points. The stroke of the punch is then adjusted, so that at the end of each stroke it does not exceed what is necessary to thrust the disk clear through the small end of the die, and so avoid waste of time and power. At the commencement of the stroke an extra length of stroke of from 4 inches to 8 inches is given in addition to the amount actually necessary to clear the die, in order to give the operator time to place the disks upon the die. The die, punch, and disk are then well greased, and the latter is placed upon the upper surface of the die. Water is admitted to the cylinder and the punch advances, driving the disk through the die and out at the smaller end, whence it falls in the form of a cup into a receptacle placed below the press. The maximum pressure attained is 1,000 pounds per square inch, as shown by the gage attached to the hydraulic cylinder. The cup is then annealed for about 28 minutes at 1,364 degrees F., having a steel clip placed round it. The scale which forms on the surface of the cup is subsequently removed by pickling in lead-lined wooden troughs containing dilute sulphuric acid, of a strength of 1 to 4, for a period varying from 8 to 15 minutes according to the strength of the bath. The cups are then washed by immersion in lead-lined wooden troughs, through which runs a stream of water, every trace of acid being quickly removed. The second cupping operation is made in exactly the same manner as the first, except that the punch and die shown, Fig. 1, are substituted for those previously used, the same precautions being observed for centering and lubricating. The maximum hydraulic pressure indicated by the gage is 1,150 pounds per square inch, while the subsequent annealing lasts 20 minutes at a temperature of 1,202 degrees F. The pickling and washing processes which follow this and all other annealings are as before described. The behavior of the metal during cupping is an efficient test of its quality. The presence of impurities or improper annealing are quickly shown by cracks or a roughened surface.

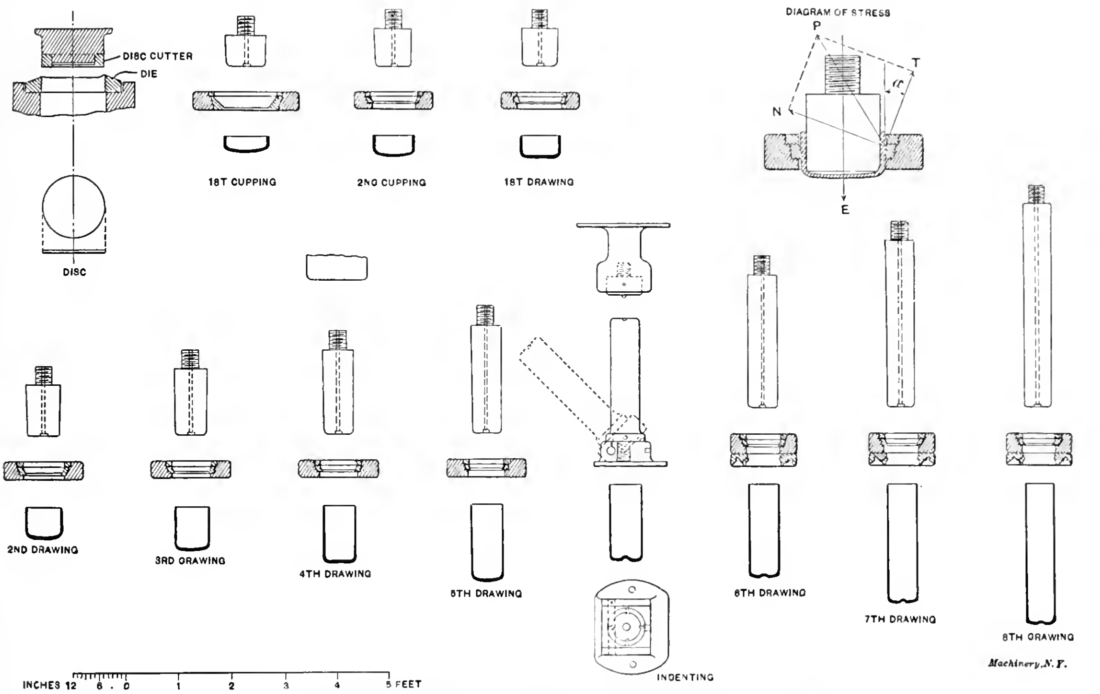


Fig. 1. Press Tools and Processes used in making Cartridge Cases for Quick-firing Guns.

First Drawing.—Fig. 1 shows the punch and die used in this operation, also the resulting piece. The maximum hydraulic pressure is 1,300 pounds per square inch. The pieces are then annealed at 1,202 degrees F. for 28 minutes.

Second Drawing.—This is performed with the tools shown in Fig. 1 with a maximum hydraulic pressure of 1,350 pounds per square inch. The subsequent annealing is at 1,202 degrees F. for 26 minutes.

Third Drawing.—This is performed with the tools shown, with a maximum hydraulic pressure of 1,320 pounds per square inch. The subsequent annealing is at 1,184 degrees F. for 25 minutes.

Fourth Drawing.—Before drawing, the bottom of the piece is flattened preparatory to indenting, which takes place after the fifth drawing, and is necessary for the formation of the primer hole. Flattening is accomplished by pressing the piece between the punch and a flat steel disk supported on the die. The disk is then withdrawn and the drawing proceeds as usual. The tools are shown. The maximum hydraulic pressure is 1,000 pounds per square inch, and the subsequent annealing is at 1,166 degrees F. for 22 minutes.

Their expansion at the moment when drawing is complete, and when they are relieved from the considerable lateral pressure, prevents their being again drawn up through the die by the retreating punch. But from the sixth drawing onward, the lateral pressure is less, and other means are adopted. Under each die is an attachment containing eight fingers pressed inward toward the axis by springs. During drawing, they give way before the advancing case, retiring into recesses. But when the end of the case has passed them they spring out and keep the case from following the punch back, the inclination of the recesses in which they move assisting this action. The sixth drawing may be performed either on the 18-inch or the 16-inch horizontal press, either having sufficient power. The subsequent annealing is at 1,166 degrees F. for 18 minutes.

Seventh Drawing.—The tools used for this operation are shown. The subsequent annealing is at 1,166 degrees F. for 15 minutes.

Eighth Drawing.—The tools used for this operation are shown. The subsequent annealing is at 1,112 degrees F. for 14 minutes.

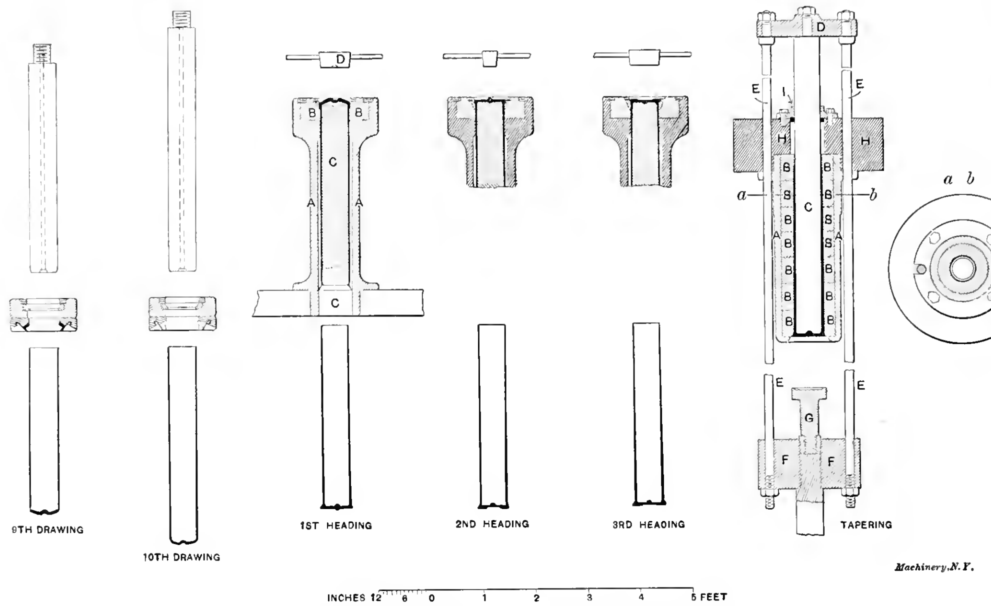


Fig. 2. Finish Drawing. Heading and Tapering the Cases

Fifth Drawing.—This is the last operation performed in the vertical press. The tools used are shown, the maximum hydraulic pressure being 700 pounds per square inch. The subsequent annealing is at 1,166 degrees F. for 20 minutes.

Indenting for Primer.—This operation is performed in the vertical 1,000-ton press. Upon the ram which moves upward is placed a pressure plate, to which is hinged a steel punch-shaped piece having the same external form as the interior of the cartridge-case as it leaves the fifth drawing, and with an indentation at the top. This can be hinged to one side to facilitate the insertion and withdrawal of a cartridge case. Upon the under side of the upper head of the press is a fixed holder, into which is screwed a flat piece of tempered steel having a small projection in the center. The object of this is to form, in conjunction with the recess in the punch, the metal boss on the inside of the case, for the primer. The cartridge case is subjected to a pressure of about 314 tons between the two surfaces, with a hydraulic pressure of 2,500 pounds per square inch. No annealing is required after indenting.

Sixth Drawing.—From this operation onward the two larger of the three horizontal presses are used, because the length which the cartridge-cases have now reached does not permit of their manipulation in the shorter-stroke vertical press. The tools used for the sixth drawing are shown. Up to this point the cartridge-cases have been able to strip themselves from the punches by catching on the underside of the dies.

Ninth Drawing.—The tools used for this operation are shown in Fig. 2. The subsequent annealing is at 1,058 degrees snap," for it is no such thing.

Tenth Drawing.—The tools used are shown in Fig. 2. This is the last drawing operation, and the blanks undergo no annealing upon its completion.

Heading.—The formation of the head of the cartridge-case is one of the most interesting of the operations in the process of manufacture. The total pressure which the head of the cartridge is called upon to stand under fire is enormous. With the 6-inch quick-firing gun used in the Spanish service, for which the cartridge cases are intended, the pressure caused by the explosion is about 17 tons per square inch. Even this pressure is exceeded when testing the guns, which is done with three discharges at a pressure of 20 tons per square inch. When the area of the cartridge-case head is considered, some idea may be formed of the enormous aggregate pressure to which it is subjected. It is essential for the satisfactory working of the guns that no deformation should take place under fire, and it is therefore important that during manufacture the head should be subjected to a pressure two or three times that likely to be experienced in practice. The operation of forming the head is made in the vertical 2,500-ton press in three stages. The tools used for the first stage are shown in Fig. 2. An iron casting, *A*, termed a bolster, is placed upon the ram of the press and serves to support the die-holder and die *B*—which latter imparts the form of the

flange to the head. Inside the bolster is fixed a steel stem C, over which the cartridge-case is slipped in the condition in which it leaves the tenth drawing. This stem, which must be capable of withstanding an aggregate pressure of 1,650 tons, is of the best hardened steel, and is without question the most delicate of all the tools employed in the process of manufacture. The first heading operation is performed by inserting the cartridge-case between the stem and the bolster. Upon the top is also placed the punch D of hard steel, provided with a central depression, the object of which is to reduce the area of contact over which pressure is exerted on the head of the cartridge-case. The total pressure is 1,600 tons, which leaves the head with a central internal and external projection, and forces the metal outward to form a flange.

In Fig. 2 is shown the second heading operation. This is performed with the same tools as the first, except that a smaller punch, 3 inches diameter, is placed over the cartridge-case, instead of the punch D previously used. A total pressure of 600 tons is exerted, with the result that the outside projection is flattened, and all the metal is driven into the internal boss, thus allowing sufficient metal for the primer holes. Finally, the third heading operation is performed with the tools shown, a total pressure of 1,650 tons being applied, with the result that the head is rendered flat and shapely.

Tapering.—This operation is for the purpose of giving to the cartridge-case its final external form, enabling it to fit the chamber of the gun, and to be easily inserted and withdrawn. It is performed in one or the other of the horizontal presses, in order to take advantage of their longer stroke. To the fixed head H of the press, Fig. 2, is bolted the cast-iron bolster A, inside which are placed seven rings of tempered steel B, the internal length of which when thus assembled is exactly equal to that of the gun chamber. The cartridge-case is driven into this space by the press, but as it is necessary forcibly to extract it after the operation, the special apparatus shown is made use of. The cylindrical extractor C, having a head shaped to fit the inside of the headed cartridge-case, is connected rigidly with the ram of the press through the crossheads D and F and the tie-rods E, and moves therewith, its position being kept central by the guide I. The punch G, bolted to the ram of the press, forces the cartridge-case in during the forward stroke, while the extractor C forces it out during the return stroke. At Trubia the tapering is divided into two operations with annealing between, to avoid risk of cracking. Before the first tapering the cartridge-case is annealed at 1,040 degrees F. in a small vertical furnace, care being taken to allow the head to remain outside the furnace in the air. It is then placed in the press and forced about half its length into the chamber, the precaution being taken to adjust the stop of the press so as to limit the stroke to half its usual length. On the return stroke, by the aid of a wooden distance-piece inserted between the extractor and the head of the cartridge-case, the latter is forced out. The case is then returned to the vertical annealing furnace, where it is exposed to a temperature of 932 degrees F., care being taken as before not to anneal the head. Tapering is then completed in the press, the cartridge-case being driven completely home into the die chamber.

Other Mechanical Operations.—The remainder of the operations are of a mechanical nature, such as turning the end, the head, the steps in the chamber, the attachment for the primer, cutting to the exact length, etc., none of which involve any features of special technical interest. It may, however, be mentioned that throughout the whole course of manufacture the thickness and diameter of the cartridge-case are carefully checked with calipers and gages, and particularly for the first two or three cases in each lot, in order to verify the accuracy of the dies and the setting of the tools. The ends of the cases are frequently turned to length between the various drawing operations, since there is a tendency, due either to the irregularities of metal or to uneven annealing, to stretch unequally, leaving ragged edges. It is also of great importance that the thickness of the end of the cartridge-case should be closely checked, and this is performed by limit gages. Lubrication of the punches and dies is effected by olive oil or soapy water.

PRACTICAL DONT'S FOR MACHINISTS - 2.

H. E. WOOD

Don't argue with your foreman.
Don't make hammer marks in your work.
Don't run your lathe tool into the faceplate.
Don't use unfaced nuts in building a machine.
Don't show your prejudices against "jig work."
Don't lay out scratch lines on a sandy surface.
Don't sharpen a thread caliper to a sharp point.
Don't let your lathe tool strike the chuck jaws.
Don't let your file strike against the vise jaws.
Don't leave brass or emery in your eyes over night.
Don't try to mark tempered tools with steel letters.
Don't try to knurl a piece of work without oiling it.
Don't use a chisel dry to chip boiler plate or steel.
Don't put a hacksaw in the frame backward; it is bad.

Don't make a shaft exactly to size, or length, when it is warm.

Don't break a tool, and then say: "It was broken when I got it."

Don't run a lathe an instant after the center begins to squeal.

Don't be too quick to laugh at the way a new man goes at a job.

Don't run a hacksaw blade up close to the end of your vise jaws.

Don't forget to oil your machine every morning; it works better.

Don't let a lathe dog's tail pinch against the slot in the faceplate.

Don't do a job of scraper work without crossing the scraper marks.

Don't cross the belt on a drill press when a green boy is using it.

Don't forget that oil is one of the best friends that machinery has.

Don't blow filings or chips in among the running parts of a machine.

Don't do any chipping unless you know where the chips are flying to.

Don't tamper with adjustable dies or reamers, outside of the toolroom.

Don't forget to stamp the "part numbers" on all parts of a new machine.

Don't use a wrench on a tap or reamer shank that is too large to fit it.

Don't put an oil-hole at each end of a bearing, without one in the middle.

Don't interfere with a machine when another man has a job set up in it.

Don't forget that red lead works better in some places than black lead.

Don't hide the lathe tools and dogs so that other workmen can't find them.

Don't drill sheet metal or brass with a twist drill; use a "farmer drill."

Don't forget that a line measurement is not the same as an end measurement.

Don't forget to provide oil-holes to supply all running parts of a machine.

Don't forget that cast iron scale is harder than tempered tool steel.

Don't use a cup-point setscrew in a tight pulley if you can get a round point.

Don't use a single lip planer tool when you can conveniently use a gang tool.

Don't stick files on end in the floor, someone may accidentally fall on them.

Don't dispute your foreman's authority, even if you know he is not a machinist.

Don't fail to observe system in your detail work, either at the lathe or bench.

Don't use taper wedges to shim up under planer work, but always use flat shims.

Don't forget that a cutting-off tool should have equal clearance on both sides.

Don't think that the road man machinist has an "easy snap,' for it is no such thing.

Don't grind a shaper or planer tool with as much clearance as you would a lathe tool.

Don't say "I just oiled it" when the machine you are operating sticks for want of oil.

Don't use the corner of a steel rule for a scratch awl, or to mark on rough castings.

Don't forget that a fairly good center-punch may be made from a piece of a round file.

Don't get into the "rut" of doing your lathe work the same as your father always did it.

Don't forget that cast iron will crawl or spring every time you take a chip off from it.

Don't forget that vise jaws are hard, and should not be struck with the file or hacksaw.

Don't forget that a combination square blade with two stocks makes an excellent try gage.

Don't allow hot babbitt metal to come in contact with water, or moisture, or rust.

Don't forget that there is air in an oil channel that cannot escape unless it has a vent.

Don't pull harder on one end of a tap wrench than you do on the other; it makes bad work.

Don't make a finishing cut on cast iron with a fine feed; a wide feed looks much better.

Don't think that a laborer who has been in one shop for years, knows nothing about the work.

Don't clamp a piece of work into a milling machine vise without the proper support under it.

Don't face off a large disk in a lathe chuck without a support from it to the tailstock center.

Don't hold a mill file at right angles to the shaft in a lathe if you want it to cut very fast.

Don't forget to make allowances for expansion and contraction when working on steam engine work.

Don't say "someone must have hit it," when you have broken a tap off in work through negligence.

Don't try to wipe dust or iron out of your eyes with cotton waste; the waste is dangerous.

Don't forget that a flywheel, pulley, or handwheel, should be balanced up before leaving the shop.

Don't pour babbitt metal into any place for machine work without having a riser at each extremity.

Don't forget that one of the hardest jobs to do, is to file a surface exactly flat and straight.

Don't forget that the warmth of your hand will change the size of a caliper or gage of any kind.

Don't forget that chloroform and camphor makes a good solution to use when drilling tempered steel.

Don't forget that the hardest fit to make on a lathe is what is called a wringing or twisting fit.

Don't try to start a plug tap in a hole when it is convenient to start the thread with a taper tap.

Don't try to put a second tap through a clearance hole and strike the thread made by the first tap.

Don't forget that a surface, polished with oil will keep clean much longer than one polished dry.

Don't forget that a round piece of work can be made on a planer, and a square piece on a lathe.

Don't depend on friction to hold a piece of work on a planer bed, but put positive stops against it.

Don't brush dirt or chips off from any part of a machine unless you know where they are falling to.

Don't open the shop windows and let the cold damp air blow in onto newly finished parts of machinery.

Don't try to strengthen a cold rolled shaft with one end in the chuck and the other end on the center.

Don't laugh at a machinist who has learned his trade in a "one-horse job shop" for he may outclass you.

Don't forget that the greatest of all the secrets of the machinist's trade lies directly between the caliper's points.

Don't pour babbitt metal into a damp clay runner without covering the exposed surfaces with oil; kerosene is the best.

Don't peen a shaft straight and expect it to run true after a cut has been taken over the spot that has been peened.

Don't refuse to tell or show the apprentice what to do, for you once had to learn all that you know.

Don't forget that more time is lost between changing tools and changing pieces, than while the tool is running.

Don't forget that plumbago, graphite, or black lead, will prevent a shaft from running hot sometimes when oil fails.

Don't forget that a round file and a monkeywrench together, will make an excellent pipe wrench in emergency cases.

Don't forget to make sure that your tap carries the same number of threads per inch as the bolt, before tapping the hole.

Don't forget that a strong blast of cold air works very similar to oil upon a drill, and in many cases does better service.

Don't forget that many different chisels or tools may be used for drawing a drill hole over to the center where you want it.

Don't run a reamer into a piece of work in a lathe chuck without having your toolpost and carriage up against it to prevent it from running in too fast and breaking something.

Don't let your bolt slots fill up with chips and dirt; it is better to fill them up with strips of wood fitted up for the purpose. This will also save your time in cleaning up your machine.

Don't cast a solid babbitt box around a bare shaft if you expect to get it out easily. A piece of thin paper (coated with a little common soap to make it stick) wrapped around the shaft will be a great help.

Don't forget that it is extremely bad practice to lay anything hard of any kind on the ways or bed of a lathe; it is best to always keep the bed covered with smooth boards fitted up purposely.

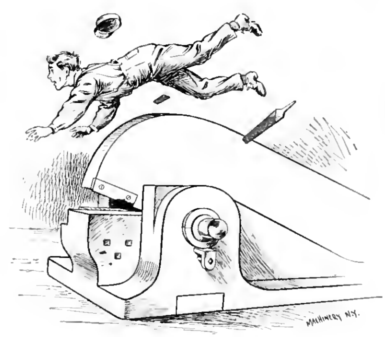
Don't always blame the hand die if it crumbles the thread on a bolt, for the fault may arise from clogging up of chips, lack of proper kind of oil, lack of hitching back and forth, or lack of judgment in many ways.

Don't forget when you are tightening or loosening the bolts in a bracket or cap you should not make one bolt tight before the others are nearly up to their places, and should never take one bolt clear out until all the others are loosened up.

* * *

"HOW HE CUT OFF THE FILE."

He was a big burly Swede, and the boss thought he had a prize. He said he "did file some little," so the boss gave him an eighteen-inch bastard file (what the boys sometimes call a hand-planer) and started him in on cleaning up a lot of castings. It was a warm day, and the fellow took hold of the job with a will and worked like a Trojan. Now an eighteen-inch file is not an easy tool to run, and "Swedy" had an inspiration. Down at the lower end of the room there was a big pair of bar



shears, used for shearing up railroad iron. Why not cut off about four inches of that eighteen-inch file, and make it easier to run? Down he went to the other end of the room, and waiting until the blade of the shear came up, he shoved in the file. There was a crash and two hundred pounds of Swede went flying through the air and landed against the side of the building with a broken arm. The king bolt on the shears was broken and a big bite taken out of the upper knife—but he cut off the file.

A. P. PRESS.

MILLING MACHINE FIXTURES.—3.

E. R. MARKHAM.

We often have to mill articles of cast iron or other metals which are not uniform in size or shape, and which would not bed alike in any fixture, without means of compensating for the irregularities. The writer has seen columns of milling machines, which weighed 400 or 500 pounds, sprung out of true when on the planer table by tightening a holding bolt,

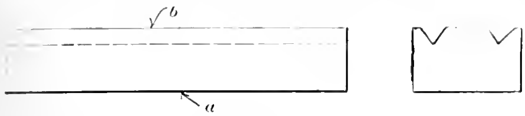


Fig. 27.

and the wrench used was an ordinary 6-inch wrench apparently applied with small force. To secure a good job, it was necessary to block under the piece very carefully and then fasten it securely for the roughing out, and for the finish cuts the strain on the clamps had to be removed entirely, or nearly so. If it is possible to spring a large mass of metal in this manner, it is apparent that comparatively weak pieces may be distorted very easily. For this reason it is necessary many times to provide adjustable supports at the points where

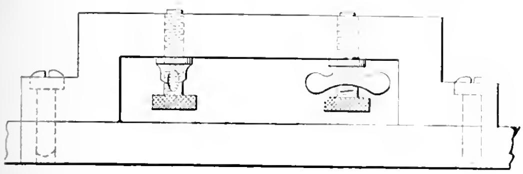


Fig. 28. Fixture for Holding the Piece shown in Fig. 27.

the fastening devices are located and also at points where the pressure of the cutter would have a tendency to spring the piece.

Fig. 27 represents an iron casting, the surfaces of which are to be milled. As castings will distort more or less in cooling, and as they are very liable to alter their shape when the surface "skin" is removed, it is often necessary to provide fixtures with adjustable supports for holding the piece, as shown in Fig. 28. In milling a piece like that of Fig. 27, such

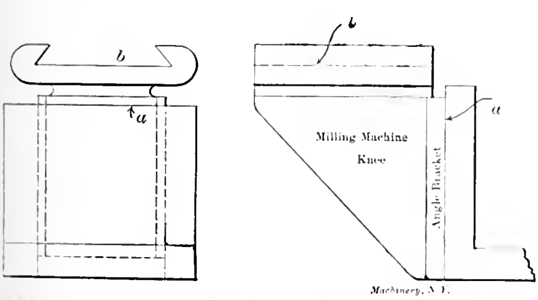


Fig. 29. Methods used to Accurately Finish a Milling Machine Knee.

a fixture should be used when taking roughing cuts on surfaces *a* and *b*, and the finish cuts on surface *b*.

In the case of work that must be very accurate as to dimensions and truth of finished surfaces, it will be found necessary to finish the surface *a* approximately true by means of grinding or scraping before milling the surface *b* for finish. This is especially true with such work as the knee of a milling machine as shown in Fig. 29, where it would be necessary to rough drill the surfaces *a* and *b* and finish mill *a*. After this, the knee should be "rough scraped" to give it a bearing against the fixture and to prevent it winding or twisting, as would be the case if the surface *a* were not true and were clamped against the fixture. To attempt to scrape these surfaces and get out a wind occasioned by inaccurate milling, owing to one of the surfaces not being flat against the holding device, when the finishing cut was taken over the other surface, would cause much needless expense.

While the above remarks are applied directly to the milling of a milling-machine knee, they are equally applicable to any piece of work that must be true, and yet whose shape or material renders it liable to spring as a result of some machine operation.

There are jobs which require a number of cuts on one side and which must be of a certain *uniform* depth from a given surface. If the pieces are of a uniform thickness they may be held in the usual manner, by having the under side of the piece bear against the seating surface of the fixture and the

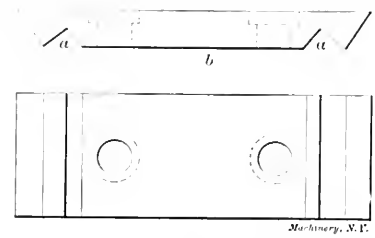


Fig. 30.

cuts taken on the upper side. If, however, the pieces are not of a uniform thickness and the cuts must be of an exact depth some other method of holding must be employed. Fig. 30 represents a cap used for holding a traveling carriage in place on a knitting machine. The V grooves *a a* must be of given depth from the surface *b*, and owing to certain conditions it is practicable to mill that surface at the time the grooves are milled. The distances from the screw holes must also be equal.

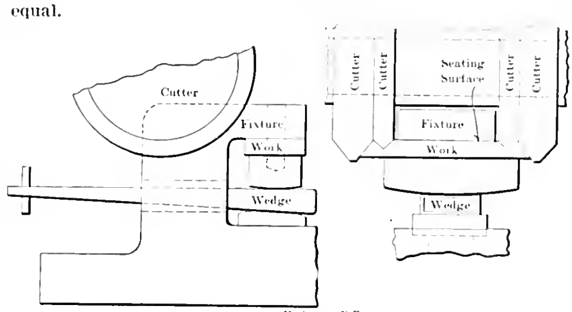


Fig. 31. A Fixture for Holding the Piece shown in Fig. 30.

A fixture of the design shown in Fig. 31 was made to hold the cap when milling the V slots and bevel on ends. It will be observed that it is an inverted fixture and that the surface *b* of the cap, which has been previously milled, rests against an under surface of the fixture. Pins which fit the screw holes in the cap project from the seating surface of fixture and enter these holes, thus properly locating the cap, which is securely held against the seating surface by means of the wedge. Between the wedge and cap is placed a block, as

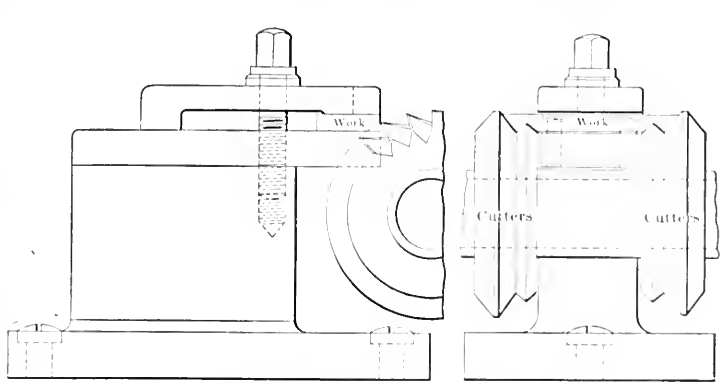


Fig. 32. Alternative Fixture for Holding Work shown in Fig. 30

shown. When the wedge is driven forward the block may be removed and the cap taken from the fixture. The pin at the thin edge of the wedge prevents the wedge from being driven entirely out of the fixture.

A fixture of a different design, which somewhat simplifies matters, was made for this job, but as it was but little out of the ordinary I will not describe it. My idea in describing the above design is that at times it is necessary to use a fixture of this character.

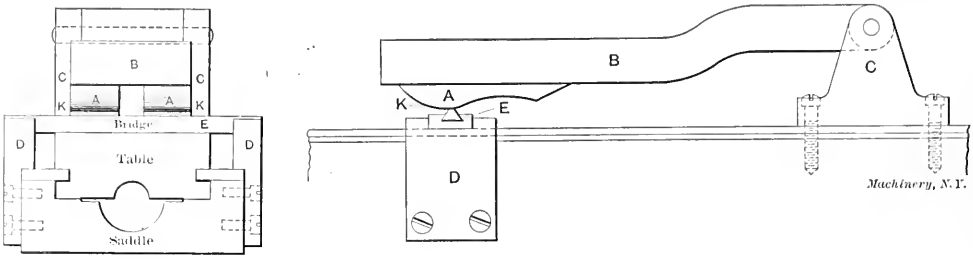


Fig. 33. The Principle of the "Bridge Milling" Fixture.

At times when fixtures of the character mentioned are to be used it is wise to make them of the style shown in Fig. 32, the cutter being beneath the fixture. In this case the seating surface being uppermost is more easily cleaned than when a fixture as shown in Fig. 31 is used.

Bridge Milling: A method of milling a certain class of work which is not used so extensively as it was a number of

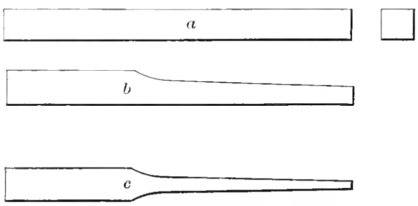


Fig. 34. Sample of "Bridge Milling" Cuts.

years ago, and which is entirely unknown to many mechanics, is known as bridge milling. In some shops work is done on profiling machines which might be done in a satisfactory manner by this method and at a fraction of the cost.

The desired shape is produced by means of a form, *A*, which is securely fastened to the movable leaf, *B*, of the fixture, as

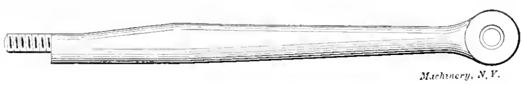


Fig. 35. Milling Cut on a Bicycle Crank.

shown in Fig. 33. This leaf is swung between two uprights, *C C*, by means of a heavy steel pin. The base of the uprights is securely fastened to the table of the milling machine by screws. To each side of the saddle, and directly opposite each other, are fastened posts, *D D*, which support the bridge, *E*, reaching across the table. The bridge should be located but a trifle above the table, say 1-1,000 inch, in order that the table of the

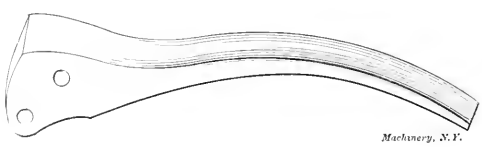


Fig. 36. Handle for Cutting Pliers.

machine may prevent it from springing more than that amount when pressure is exerted by the operation of cutting.

In the surface of the bridge is cut a slot to receive a hardened steel piece, *K K*, which, being narrow at the top, allows the movable leaf to move in conformity to the shape of form fastened to its under side.

Fixtures of this character may be used many times for milling a number of pieces at once. I recall a fixture for milling the legs of machinists' callipers. These were milled from pieces of square machinery steel to the shape shown in Fig. 34, where *a* represents the piece of mild steel cut to length, *b* after one side was milled to shape, and *c* after both sides had been milled. Eight pairs of legs were milled at a time and at a fraction of the cost of drop forgings.

At another time we rigged up a fixture for bridge milling the flat portion at the end of the bicycle crank, Fig. 35. As in the case of the caliper legs, we used a double fixture and were able to mill six pair of cranks at a time, milling the right-hand crank in one fixture and the left-hand in the other. These were located side by side on the same machine. On account of the unequal quantity of stock removed at the various portions a slight inaccuracy was observed, but was corrected by running the cutters across the work twice at the same setting of the pieces.

At another time we found that by substituting the operation of bridge milling for that of profiling we were enabled to mill the rounded portion on the cutting upper handles shown in Fig. 36 at a fraction of the former cost, and at the same time opened the way to do other work on the profiling machine, thus enabling us to get along without adding to our equipment as would otherwise have been necessary.

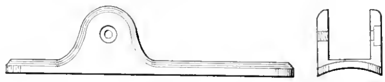


Fig. 37

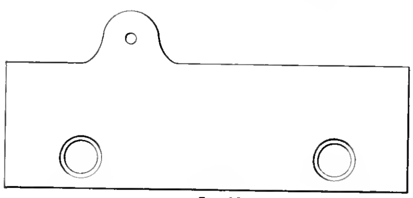


Fig. 38

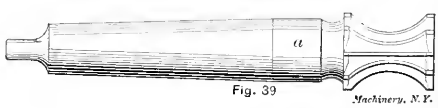


Fig. 39

Fig. 37. Vernier Sight Base. Fig. 38. Vise Jaws used for Work shown in Fig. 37. Fig. 39. Form Cutter with Guiding Surface.

In the first two examples of bridge milling cited, the milling was done with straight cutters, whose teeth were cut spirally, the helix being right-hand on one cutter and left-hand on the others, to do away with the thrust incident to long spiral mills where the teeth of both are of the same hand helix. In the case of the cutting nipper leg the cutter used was concave in shape.

The old adage that "Necessity is the mother of invention" is nowhere more apparent than in the small shop where a great variety of work is done with a limited equipment. The fact that work is done in comparatively small "batches," with little assurance that another lot will ever be made, renders it inadvisable to procure machinery specially adapted to the work, and it is found necessary many times to use the planer for a job of broaching, or a punch press to do work that would be done on a key-seating machine if one were at hand. In

fact, it is found necessary to use a machine for purposes that under other circumstances would be considered but ill adapted to the work in hand. For this reason we find many of our best mechanics are those who learned their trade in the kind of a shop just mentioned. A few years' experience of this kind develops the faculty of thinking to a degree that would not be probable without such experience.

I recall a piece of work—a Vernier sight base—Fig. 37, which it was necessary to round on its upper portion. At first thought this appeared to be a job for the profiling machine, but that machine was taxed to its utmost capacity, so a pair of jaws of the form shown in Fig. 38 were made. The upper portion of the stationary jaw was made to act as a former and the jaws were fitted to the vise on a hand milling machine. The cutter was of a shape that insured its cutting the desired curvature on the base, and a portion was left as shown in Fig. 39 at *a* to rest on the form part of jaw. This was found to work very nicely. It was, of course, necessary to harden the jaw on the portion used as a form, so it was quite hard. The portion of shank of the mill marked *a* was left quite hard and was ground to insure its running true after the shank was ground to fit the collet.

Since making these jaws, the writer has had occasion to make many others for use in machining other gun and bicycle parts, and in some cases has found them to work more satisfactorily than when the same pieces were machined on a profiling machine.

* * *

GAS ENGINEERING IN THE ORIENT.

"TRAVELER."

The working of the minds of the simple and yet wonderfully studious peoples of the Orient, or even of the Anglo-Indians who have never been in manufacturing centers, is something which we machinery-using Americans cannot comprehend. Examples of the mental confusion which our unfamiliar appliances bring about in the novice occur occasionally to give us a pleasant jolt in the humdrum of daily work.

Some years ago the writer was engaged in engineering work in one of the large iron mines of northern Michigan. A big raw Finlander had recently been employed and broken in as a driller's helper. It was his duty to carry the tripod for a heavy drill, and he was taught to carry it by throwing one leg up over his shoulder, allowing the other two legs to hang down, grasping these with his hands.

The big Finn had mastered the details of this operation, and his great strength was rapidly winning him a place of favor with the driller; when one day he was sent into a neighboring stope after a wheelbarrow. He had never seen a machine of that class before, and at first could not see how he was going to get it from one stope into the other. He finally stood it up on the handles, grasped a handle in each hand, and holding the wheel up over his shoulder just as he would carry a drill tripod, stalked ahead. When he arrived in the other stope and was shown how such a complicated machine as a wheelbarrow was intended to be conveyed from one place to another, a great light and a very curious expression spread over his face. It had in it the elements of several conflicting and highly differentiated emotions.

If the non-machinery using European finds the wheelbarrow a machine requiring study, what must a modern gasoline engine be to the average Asiatic? Recently a man in charge of a machine shop in a small town in India purchased a gasoline engine from a prominent American manufacturer. The engine was properly crated and shipped, but in transit the book of instructions was lost. The engine had been mounted on heavy skids with most of the auxiliary apparatus in place. When it arrived at its destination it was dragged into the compound in which the machine shop was located by a patient elephant, always the common source of power of the Orient and of wonder on circus day to the small boy of the Occident.

They decided that it was not safe to take it into the shop before trying it, and hence the engine was set up in the yard, the boxing knocked off, all the necessary attachments made, batteries connected up, and the tank filled with gasoline. The next thing was to start it, but they lacked their book of instructions. One of the Europeans connected with the plant had the idea that all gasoline engines had to be started by rolling them continuously forward, but the makers of the engine under consideration had simplified the matter greatly in this case, as the engine is started by turning it forward until it sucks in a charge and then giving it a little over a quarter-turn back to produce the necessary compression previous to the firing of the charge.

Not knowing this the manager called a force of some twenty-five coolies, and attempted to start the machine by turning it continuously forward. This was very laborious work, and the men got bolder and bolder until they were clinging to every spoke of the pulley, and tugging as hard as they could. The compound was surrounded by a fence ten feet high, and practically the whole village had crowded into it to see the new machine. The engine made four or five revolutions before ignition took place, and this threw a good deal of charge into the exhaust pipe and muffler, so that when it finally started there was a deafening explosion in the exhaust pipe and muffler.

Fortunately the engine simply hurled its load of clinging humanity in every direction without injuring anybody, while the natives went over that ten-foot fence like a pack of monkeys, two of them landing with broken arms as the result of their haste. It was some time before even the boldest could be persuaded to come back to the compound, but they finally got used to the engine and then it was dragged into the shop and connected up for work; but the first job every morning had to be for the entire force of twenty-five or more coolies to get hold of the belts and flywheels and start the engine by rolling it over continuously against compression.

In due course of time the owner of the plant visited the United States and called upon the gas engine manufacturers.

"How do you like that 40-horse power gasoline engine you purchased?" said the manager.

"Oh, it runs fine; but why in the world don't you Americans invent some better way of starting it? It takes all the coolies I've got to start the engine every morning, after that it runs all right all day long, and takes very little or no attention."

"How do you start the engine?" inquired the manager.

Then followed a recital of the facts given above. Then they took a recess for the manager to laugh, and after he had got his breath once more he said, "I can start a 50-horse power engine alone."

"You must be stronger than you look, for it takes 25 strong coolies to start it with us."

The matter was settled by a visit to the testing floor, where the manager stopped four or five engines and started them all without any difficulty. The purchaser was very much surprised, and then incredulously wanted to try the trick himself. After starting the first engine and finding that he could really do it, he acted like a small boy with a new toy; got them to stop all the engines in the line, and went up and down the line along the length of the testing floor starting and stopping those engines for half an hour. He turned to the manager, "I wish I could go to India *to-night* and show them how to do this!"

The manager suggested sending a book of instructions, but the purchaser insisted that he would write the directions himself, and hurried off to the hotel, where he wrote a ten-page letter and started it off to suspend that 25-coolie operation.

* * *

Some interesting facts regarding the endurance of a centrifugal fan blower were brought out in the discussion at the last meeting of the Pittsburg Foundrymen's Association, regarding the relative merits of the positive blower and the fan. It was stated by a representative of the Westinghouse Air Brake Co. that they installed six positive blowers in their foundry and after six months replaced them with fans. At this plant the iron is melted continuously and the blowers were compelled to operate 23 hours daily. The blowers were operated at a pressure of 16 ounces and at the beginning of a heat would run up to 20 ounces. Regarding the life of fans, he said that they have used a No. 9 fan for 15 years, and during that period it was operated 23 hours every day except Sunday, and required no repairs whatever.

THE ALLIS-CHALMERS STEAM TURBINE.

A steam turbine recently started up at the Washington Street power house of the Utica Gas & Electric Company, Utica, N. Y., is the first to be put into operation by the Allis-Chalmers Company, and is shown in Fig. 1.

This turbine is rated at 1,500 kilowatt normal load, and runs at a speed of 1,800 revolutions per minute. It is direct-coupled to an Allis-Chalmers two-phase, 60-cycle revolving-field alternator, operating at 2,500 volts. The unit has a continuous overload capacity of 25 per cent., with a 3-hour 50 per cent. overload capacity without exceeding a safe generator temperature, and capable of a 100 per cent. safe momentary overload. Artificial ventilation by means of an electrically-driven fan blower will, however, enable the unit to be run safely beyond its rated overload capacity.

sufficient for stiffness, the shroud ring does not have the disadvantage of a solid shroud which acquires a dangerous temperature by friction in case of an accidental contact of the rotating and stationary parts. The use of a protecting shroud ring not only stiffens the blades, but enables the working clearance to be made smaller than in the case of naked blade tips, without danger in case of accidental contact, thus reducing the leakage loss to a minimum. The shroud also acts as a safety device, protecting the blades in case of contact between stationary and rotating members, and preventing any individual blade from working loose and causing damage.

The entire blading is produced by machinery and is made up in half rings in the blading shop and carefully inspected before being inserted in the turbine.

Fig. 2 shows the general scheme of the blading. Fig. 3 two

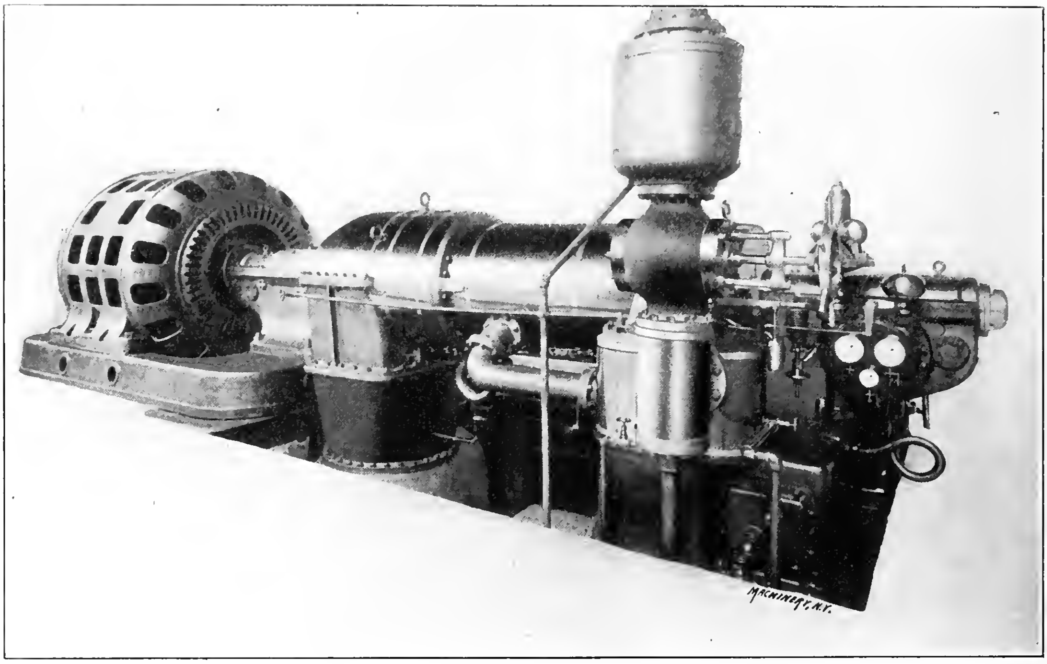


Fig. 1. Fifteen-hundred K.W. Allis-Chalmers Turbine Installed at Utica, N. Y.

The turbine follows the well-known Parsons type but embodies a number of features which are new in this country. The chief distinguishing feature is the blading. The roots of the blades are formed in dovetail shape by special machinery, and are inserted in slots cut in foundation or base rings; these slots being formed by special machine tools in such a way as to exactly conform to the shapes of the blade roots. The foundation rings themselves are of dovetail shape in cross section and are inserted in dovetailed grooves cut in the turbine casing and spindle respectively, in which they are held by key pieces, much in the same way that the well known "Lewis bolt" is fastened. In order to further insure the integrity of the construction, the key pieces or rings after being driven into place are upset into undercut grooves.

Another noticeable feature of the blading is the method of reinforcing and protecting the tips of the blades, which is a point upon which much thought has been expended by various inventors. In forming the blades a shouldered projection is left at the tip. This is inserted in a slot punched in a shroud ring; the slots being punched by special machinery in such a way as to produce accurate spacing and at the same time form the slots so that they will give the proper angles to the blades independent of the slots in the base ring. After the blade tips are inserted in the slots in the shroud rings they are riveted over by specially arranged pneumatic machinery.

The shroud rings are channel shaped with outwardly projecting flanges which, after assembly in the turbine, are turned and bored to give the necessary working clearance. The flanges of the channels are made so thin that, although amply

half rings of blades ready for assembly in a turbine, these half rings being respectively the smallest and largest ones, used in a turbine of the size installed at Utica. Fig. 4 is from a photograph showing the uniformity of the blading.

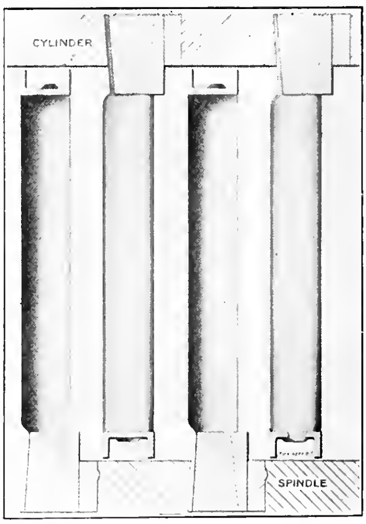


Fig. 2. Scheme of he Blading.

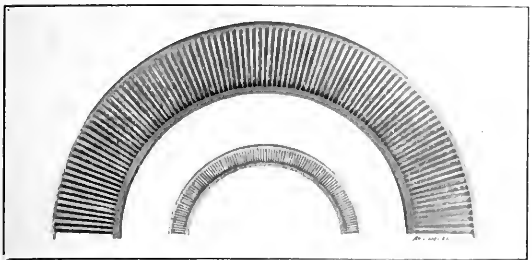


Fig. 3. Two Half-rings of Blades—the Largest and the Smallest in the Turbine.

Another special feature of this turbine will be noticed by referring to Fig. 5, *viz.*, the absence of the usual low-pressure "balance piston;" the photograph showing only two balance pistons instead of the three pistons formerly used in this type. In the Allis-Chalmers construction there is, however, a third balance piston, but instead of being at the high-pressure end, as formerly arranged, it is at the low-pressure end, and as it is smaller than the large end of the spindle it is hidden from sight in the photograph. By making this piston in such a way that its circular area is equal to the annular area of the pistons used in the older construction, the low-pressure balance piston is made much smaller. Instead of reducing the leakage past this piston by means of "dummy packing," as in the high-pressure and intermediate pistons, and as

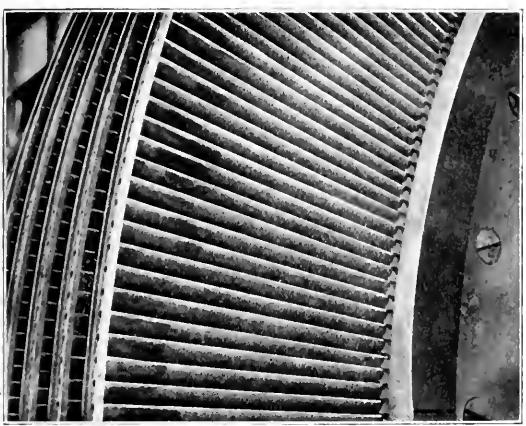


Fig. 4. From a Photograph, showing Uniformity of Blading.

used in the low-pressure pistons of the older construction, a labyrinth packing of radial baffling type has been adopted, thus eliminating small axial clearance in this turbine. The advantage claimed for this construction is the use of smaller working clearances in the high-pressure and intermediate balance pistons

There are a number of other points of improvement claimed for the Allis-Chalmers construction which will not permit of description within the space of the present article. These include details of spindle construction, governing mechanism, lubrication, and other minor features.

The alternating current generator of the Utica outfit also is deserving of more description than the present article will allow. Perhaps the most noticeable feature of this generator is the substantial design of the revolving field, providing great strength and at the same time giving the thorough ventilation which is essential. Particular attention has been paid to the insulation, as may be inferred from the fact that the armature

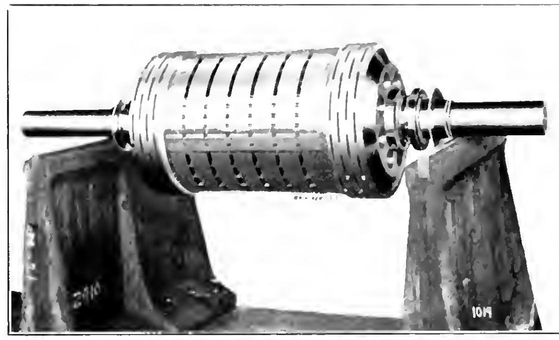


Fig. 6. Revolving Field of Generator.

(Fig. 6) was subjected to an alternating current insulation test of 10,000 volts for the period of fifteen minutes. This generator was built at the Bullock Works of the Allis-Chalmers Company at Cincinnati, where the generators for all of their other turbine outfits are being built.

The Allis-Chalmers Company, in entering the steam turbine field, effected an alliance with the Turbine Advisory Syndicate of England, including Messrs. Willans & Robinson, the high-speed engine builders, of Rugby; Yarrow & Company, the torpedo-boat builders, of the Isle of Dogs, London; and the Neptune Shipbuilding Works, Walker-on-Tyne. An agreement has more recently been effected with Hon. Charles A. Parsons, for interchange of data, thereby giving the Allis-Chalmers Company the benefit of the vast experience of Mr. Parsons, the original inventor of this type of turbine.

* * *

The *Woodworker* tells of a man who owned a mill in which the main driving wheel was located in a pit where the water collected to such an extent as to interfere with the belt, causing it to slip. He overcame the difficulty by putting some elevator buckets onto the outside of the belt, and providing means for disposing of the water as it was carried up by the buckets.

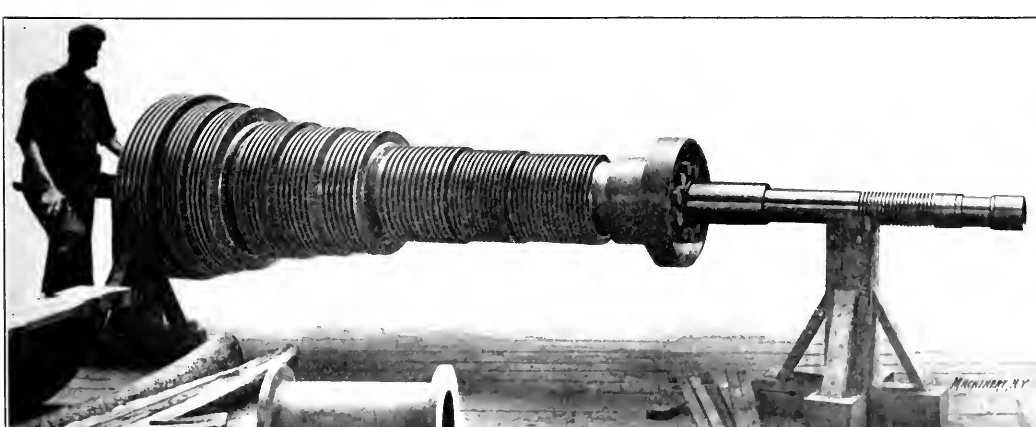


Fig. 5. View of Rotor

DRAFTING ROOM PRACTICE—PATCHING DRAWINGS.

W. G.

Mr. Robert Grimshaw's article on drafting-room practice in the September, 1905, issue of MACHINERY recalls to the writer his own experience along this line in the good old days when the drafting room did not bear the important relation to the shop that it does to-day; however, the time does not seem to be so long ago, after all. The bicycle industry, which was then in its infancy, and growing into the gigantic thing it afterward proved to be, leading to a demand for all kinds of machine tools, such as screw machines and automatic machines of all descriptions, gave a new impetus to the machine tool industry and also resulted in placing the drafting room on a better plane than it had previously occupied. At least that was the way in the shop that I was employed in at that time. Previous to this we had no standards of any kind for our drawings. Card indexes were unheard of, blueprints were considered too expensive and the making of tracings an unnecessary expense and waste of time. Our drawings were made any old size, and of a character that would not be considered much better than rough sketches to-day. It would have been useless to make them any greater, for they were not held in very great esteem by the shop, any way. It was considered the proper thing to use any piece of stock on hand, regardless of what the drawings called for. The only time the drawings were taken seriously was when a fellow used them to cover up a hole he got into and push the blame on the draftsman. We used a heavy drawing paper for our drawings, and when they were finished, two good coats of shellac were put on front and back and then sent into the shop.

I have used all kinds of drawing paper, tracing paper, and also cloth, and believe that we can get a more accurate drawing in less time with a good grade of bond paper, say crane or any other good bond, about No. 18; and if bought in large quantities the maker will tint this paper a soft color that is pleasing to the eye. The drawing is inked in on this paper and good blueprints can be made from it. A blueprint is kept on file for reference and the drawings are seldom used. When making a drawing upon which a great deal of time is to be spent, such as the design of a new machine, the paper is dampened and the edges are glued to the drawing board. When dry it presents a surface that is smooth and taut, and is not affected by any atmospheric changes and moisture that buckle and wrinkle any drawing paper under ordinary conditions. The boards are slightly convex or spherical and the paper is mounted over a plain blueprint which subdues the brilliancy of the paper.

But making changes on these drawings is where the great saving of time comes in over tracing cloth. The pieces or parts to be changed are cut out and a new piece is pasted in and redrawn. The draftsmen soon get so expert at this that a piece 1½ inches square can be cut out and pasted in in less time than it could be erased on tracing cloth. The piece to be changed is first squared off and cut out with a knife. This is then laid over another piece 3-32 or ⅛ inch larger than the piece that has been cut out and the edges are glued all around with ordinary library paste; it is then pasted on the reverse side of the drawing. I am sending you several drawings patched in this manner. The first is an example of our average practice, and the larger one, Fig. 1, is the worst case as far as the number of patches is concerned that I have run across. Of course the blueprint will be rather light around the edges of the patch, but this only indicates to the shop where the changes have been made.

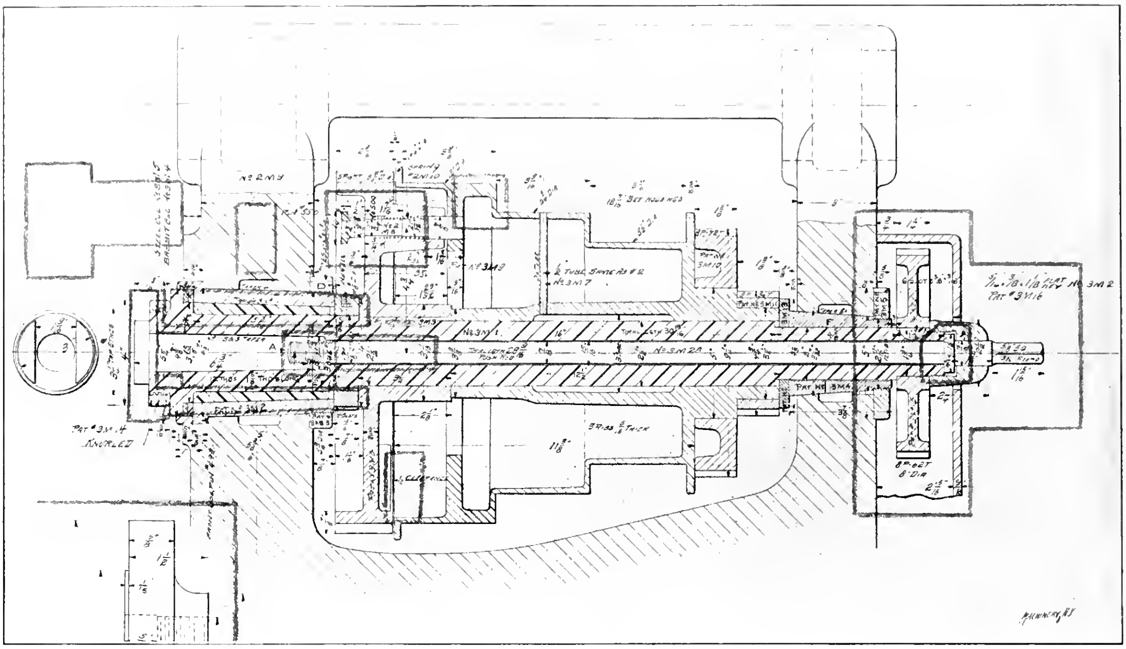


Fig. 1. A Patched Bond Paper Drawing.

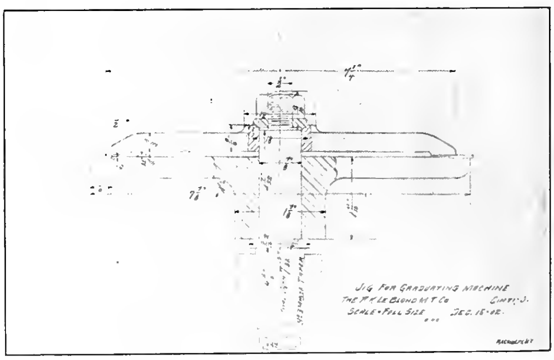


Fig. 2. Rough Sketch on Section Paper.

All records and rough sketches are made and kept on the small sheets, Fig. 2, which are about 7¼ x 11¼ inches. We have these punched, ruled and cross-sectioned at our stationers, and while the ruling is not so accurate as on the lithographed section paper, the cost is much less, only $4 per 1,000, and it serves our purpose just as well.

What the modern drafting room is most in need of is some

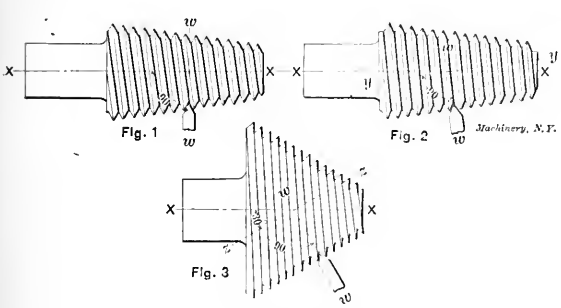
pigment for making impressions on paper that is a medium or cross between a lead pencil and the ordinary drawing ink. Something that could be used as a lead pencil, give sharp black lines, be reasonably permanent, not easily rubbed off by ordinary usage, and yet by some simple mechanical or chemical means could be quickly removed from the paper. This would do away with ink blots, spilled ink bottles, clogged pens, etc., and waiting at every few strokes of the pen for the ink to dry.

[Fig. 1 is a half-tone reproduction of a discarded drawing on bond paper which was patched in several places from time to time as changes were made. The work is so neatly done that it is scarcely discernible save when held between the eyes and the light. For this reason the patched effect would not be apparent in the cut, so we have penciled each patch around the edge, the penciling being about the same width as the lap, which is only about 1-16 inch in most cases.—EDITOR.]

* * *

TO SET A LATHE TOOL FOR THREADING A TAPER TAP.

The correct setting of a lathe thread tool for threading a taper tap such as a pipe tap, has perhaps caused as much argument among mechanics as any other machine operation, but it would not seem, in view of all that has been said and written on the subject, that there should be any doubt as to the correct setting. But, notwithstanding the fact that the correct setting has been described and illustrated in various publications, it appears there are yet men who firmly insist that the threading tool should be set at right angles to the surface of the work, as shown in Fig. 2, rather than at right angles to the axis of the tap, as indicated in Fig. 1. In this sketch, as in the others, the axis, or center line of the tap, Fig. 1, is indicated by the line x-x and the center line of the thread tool is w-w. Now, if a thread tool be set with its center line at right angles to the surface of the taper tap, Fig. 2, it will be at right angles to the line y-y. Where the tap has a comparatively slight amount of taper, as is the case with the standard pipe tap, the accuracy is scarcely discernible to the eye, and perhaps in some cases it will make little difference, but the method is wrong and is one that should not be persisted in.

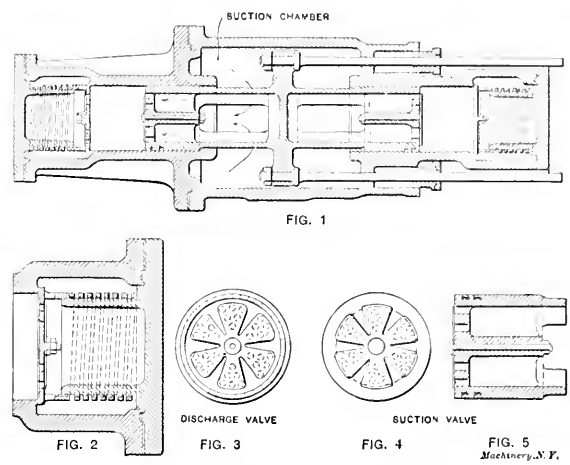


Threading a Taper Tap.

To prove that it is wrong and show the absurdity of the practice, suppose that we were making a tap having a great amount of taper. Suppose, for example, that the included angle is 60 degrees, as is the case in Fig. 3. Then, if the thread tool is set with the center line w-w at right angles to the surface of the work, we have a thread of which the lower side is at right angles to the axis x-x, instead of being at an angle of 60 degrees thereto. If the tap was of still greater included angle, the top of the thread would overlap the base, a condition which very well illustrates the foolishness of the practice. A reason perhaps for setting at right angles to the thread surface of the blank is the ease with which it can be done, using the ordinary thread gage as a setting tool, but the shank of a tap is usually turned straight, and if the thread tool is adjusted to this surface it will be correctly set. A taper tap should be threaded, if possible, in a lathe having a taper attachment, and then the conditions as laid down in the foregoing are so apparent that no room is left for argument.

AN AMMONIA COMPRESSOR WITH SMALL CLEARANCE.

A high-speed air compressor, of English make, was recently illustrated in MACHINERY, in which the principal feature of interest was the discharge valve, this being somewhat larger than the bore of the cylinder, forming, in effect an inner movable head for the bore. Its object was to give not only a large discharge opening, but to reduce the clearance space to the minimum. The same result has been obtained in a high-speed ammonia compressor built by L. Stern & Co., Glasgow, much similar in construction but with somewhat different action. The construction, as will be seen in the accompanying cuts, differs, in that the inner cylinder heads for the double-acting piston are the discharge valve seatings, but they do not lift bodily from their seats, except when the piston runs over the limits of its stroke. The discharge valves are seated on the outer faces of the heads or seatings in the usual manner, and the seating is held in place by a heavy coil spring of sufficient strength to hold it firmly in place except when the piston over-runs. The piston is connected to the piston rods by two lugs attached to the sides and these lugs work in the suction chamber which surrounds the center of the piston. The incoming ammonia gas passes from the suction chamber through large openings in the sides of the piston and from thence out through the small openings in the ends of the pistons, which are covered by light metallic plates, forming the suction valve, as shown in Figs. 4 and 5. The clearance spaces are reduced to nearly zero and the length of the connecting-rod is adjusted so that normally the valve seatings at the ends of the stroke are not disturbed. The compressor may be run at high speed economically and without fear of damage, for in case the adjustment is lost the knocking will at once warn the engineer without causing a smash-up. An advantage of the design is that the piston rods are not subjected to great variations in temperature and the piston rod glands do not work against high pressure, thus reducing leakage and the friction losses of the machine.



An Ammonia Compressor with Small Clearance.

* * *

It is said that tantalum has great possibilities when used for tool making, its toughness and hardness rivaling the diamond. Von Bolton made a laboratory experiment recently, when a sheet 0.04 inch was hammered from the first piece produced of the pure metal, and all attempts to drill a hole through it were found to be futile. Finally a diamond drill was employed, and after continuous work for seventy hours at a speed of 5,000 revolutions per minute, about one-fourth of the task had been completed, while the drill was so badly worn as to necessitate a discontinuance of the test. Tantalum is entirely non-magnetic, has a specific gravity varying from 14 to 17, and fuses at about 2,300 degrees C. (4,172 degrees F.). In the form of a wire it has a tensile strength of about 128,000 pounds per square inch.—*Mechanical World.*

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1906.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

We think the readers of this month's Engineering Edition will not be sorry that we have stepped outside the realm of mechanics sufficiently to give space to an article upon the subject of selling machine tools. It is said that it is easy enough to make a machine, but another matter to sell it. This, of course, is not strictly true, because occasionally a mechanic is bright enough or fortunate enough to hit upon an idea which, when worked out in iron and steel, will produce a machine that will sell itself. The number of instances where this has occurred, however, are few and it is the selling end of the business that usually must receive the greatest share of attention. In fact, so important is the commercial side of engineering becoming, that it begins to look as though no mechanical man could make an unqualified success, from a financial standpoint, unless he be more or less of a "commercial engineer"; that is, a man who, while versed in the science of mechanics and the art of machine construction, is also accomplished in the business of distributing the products after they are completed. Unquestionably the strongest combination that a man of ability can have is a full knowledge of the two branches of the business.

* * *

A correspondent has called our attention to a few errors which appear in past issues of MACHINERY data sheets and has intimated that such errors are inexcusable. It is true that there is no excuse for errors in matter of this character, but they *occur*, nevertheless, and it seems practically impossible for the editors of this publication to check all calculations that are necessary in the preparation of some of the data sheets published. We are dependent, to an extent, upon the accuracy of our contributors; the matter of correct proofreading rests with us, but surprising errors sometimes occur by the simple transposition of two lines, an error which is very easily made in linotype composition, and the omission of a single word will sometimes change the sense entirely. For example, in the August, 1904, sheet, the omission of the factor 1,000 gives a ridiculous result to the rule for finding the safe load for chains; for a one-inch chain it gives the working load as 16 pounds, whereas the factor 1,000, which was omitted, would make it 16,000 pounds. When it is considered that the elimination of errors from textbooks and handbooks, which are very carefully compiled and in which the factor of time is not so important as in the publication of a periodical, is a matter of years there appears to be some faint shadow of extenuation to offer. Kent's Mechanical Engineer's Pocketbook was published in 1895, but the author admits that the errors in the orginal are not all eliminated yet, notwithstanding that it has been for some years in the hands of thousands of draftsmen and designers who constantly refer to it.

* * *

EDUCATION OF FOREMEN.

The first article in the Engineering Edition of last month, by O. M. Becker, outlined some of the important reasons why more attention should be given to what he terms factory education, particularly for men who are to hold important machine-shop positions. In the current number he presents a description of one notable attempt in this direction.

The need for this becomes even more apparent when we consider the tendency of the technical schools, or at least some of them. They are not offering the opportunities that they should for this intermediate or foreman class of men. The schools are crowded and there is a constant call for instruction in a wider diversity of subjects, which means increased expense. One result of this is a tendency to raise the rates of tuition, as can be instanced in one case, where tuition is now $250 per year—almost a prohibitive sum. These schools, also, are constantly raising the requirements for entrance and call for preparation in perhaps two foreign languages, advanced algebra, trigonometry, etc. The result is that students in moderate circumstances, who have not been able to take the necessary preliminary training, will think twice before attempting a technical course. We are aware that many such institutions and some others are not conducted along the lines indicated and we will ask those interested in them not to rise and say that we have misrepresented the conditions. We are pointing out a tendency, merely, and that tendency is such as to indicate that men who are to hold responsible intermediate positions in our machine shops must look elsewhere than in the technical schools or even than in the machine shop itself to secure the training they require.

* * *

THE CARMANIA.

The arrival on December 11 of the *Carmania*, the new turbine trans-Atlantic liner of the Cunard Line, is one of the events in mechanical progress that will be recorded in industrial history. The *Carmania* is a sister ship to the *Caronia*, one of the largest and latest of the Cunarders, but fitted with reciprocating engines instead of turbines. There is thus afforded an opportunity for direct comparison between the performance of two great ocean liners having the different methods of propulsion. Singularly enough, on the day the *Carmania* arrived there were in the port of New York two examples representing the highest development of the old and new in marine machinery. There was the turbine-driven *Carmania* and the engine-driven *Kaiser Wilhelm II.*, with 44,000 horse power of reciprocating engines on board. Does the latter represent the last great example of the marine reciprocating engine that will be produced? The success or failure of the *Carmania* will in a large measure answer this question.

The difficulties that have had to be overcome in producing a turbine ship of the immense proportions of the *Carmania* can scarcely be appreciated. The turbine is essentially a one-speed machine, and does not give good economy at other than the speed at which it is designed to run. It is also a high-speed machine and it has not been easy to design propellers that would give good results at these high speeds. The reaction turbine, which so far has been used almost entirely in marine work, and is well adapted for this purpose because of the thrust exerted in this type which can be used to balance the thrust of the propeller, is also a complex machine, as is evident from the fact that the turbines of the *Carmania* have 1,250,000 blades. Any distorting of the casing or elongation or displacement of the blades, that should cause the rotating elements of the machine to come in contact with the stationary elements, would prove disastrous and provision must be made against such a contingency. These and other difficulties are serious ones, but not insurmountable, and the marine turbine now seems to have reached the critical point in its development and engineers will await with intense interest the result of this gigantic experiment on the part of the Cunard Company.

PATENTS IN THEIR RELATION TO THE GAS ENGINE AND THE AUTOMOBILE.—1.

S. M. HOWELL.

Fortunately for the progress of the gas engine art, there are no basic patents now in force upon the internal combustion motor, its essential features having been developed many years ago. And yet it is certainly true that gas and liquid-fuel engines have in recent years undergone certain very radical changes in form and dimensions. But these changes are practical developments rather than patentable inventions, having resulted chiefly from the efforts and experience of many designers, whose object it was to reduce weight and simplify construction in order to produce a suitable motive power for the automobile. The result of this has been the general adoption, by common consent, of certain simplified forms of gas engine construction, identical in operative principle with the systems devised by the early experimenters, but reduced greatly in weight, remodeled in proportions, and adapted to higher speeds and the development of greater power. Although the records of the United States patent office show about six hundred and seventy patents classified as "air and gas engines," it is apparently a fact that what may be termed the standard types of automobile and other gas engines are not within the limits of patent restriction. The plain two-and-four-cycle systems in their most simple forms have gained the favor of popular approval, in spite of the best efforts of invention to supersede them. This is no doubt due largely to a general disposition on the part of the manufacturers and users, to reduce the question of small motive power to its simplest terms, by means of an engine of few parts and easy construction. Gas engine patents are usually additions to the original structure, and would naturally be avoided in a design which had for its object the simplification of the machine.

The study of patent office records in order to trace the history of the gas engine and determine the origin of any given form of these motors, is an intricate and somewhat difficult problem. This is principally, of course, owing to the immense number of such patents, but partly also to the fact that many of them are contradictory and often claim and repeat identically the same thing. And moreover patent office classifications are somewhat incomplete, there being no separate divisions of the indices to correspond with the subclasses of the patents, and the definitions given to the various subclasses are so brief as to be often incomprehensible and entirely inadequate. It is true the office has published a number of bulletins which remedy this defect to some extent by outlining the general character of inventions included in certain subclasses, but this has not yet been extended to the subject of engines, and it is therefore necessary, in order to determine the status of any given case in regard to priority, to go over the entire index of the whole number of patents granted. The writer has given much time to this subject and believes that by dint of effort he has, at least for the purpose of this article, succeeded in reducing the matter to manageable proportions.

The origin of the four-cycle system goes back as far at least as the Otto patents of 1877. The principle, however, underlying the operation of the Otto engine and the four-cycle system as now used, was first worked out and proposed by Beau de Rochas, a French engineer, in 1862. These engines were the first really successful internal combustion motors ever built. They were of great weight and of monstrous proportions, and intended only for stationary purposes. This engine was the first to use a compressed charge, and although its method of ignition, sliding valves and other mechanical arrangements are now obsolete, its operative principle is still the basis of all modern practice in four-cycle engines.

The modern four-cycle automobile engine, as regards its general features, sometimes called the De Dion pattern, comes from the Daimler patent of 1886. This is especially true of that very common style in which the flywheels are disks inclosed within the crank case. Part of this type of construction, however—that is, the tight crank case—originated in a still earlier invention by L. H. Nash in 1883. In this engine the crank case contained oil for splash lubrication.

The two-cycle engine working a compressed charge was first proposed in the Robson patent of 1881. The Robson engine had a double-acting cylinder, the front end of which was used for previous or preliminary compression. The firing was by means of a jump spark coil and a magneto, driven by the engine. The cylinder was provided with valves through which the exhaust escaped and the fresh charge entered simultaneously. The charge was finally compressed on the back stroke and fired at each revolution, thus constituting so far a two-cycle compression engine. But the other feature of the modern machine, *viz.*, the inclosed crank case, had not yet been developed. This patent was followed by the Benz, and several others on similar lines until 1891, when the English patent of J. Day appeared.

This patent is in all essential respects the prototype of the modern two-cycle engine, as now generally used for automobile and motor boat propulsion, consisting of an inclosed crank case and a cylinder without valves, but provided with two ports, so situated as to be uncovered by the piston during the terminal part of its outstroke, the crank case being utilized as a pump for previous compressions, and being placed in communication with the cylinder by means of a transfer passage. The appearance of this invention marked a new era in two-cycle engine construction, and scores of patents followed it, all built on similar lines, but modified in various ways as suggested by different designers. Unfortunately for the inventor of this engine, the patent seems to have no legal force in the United States. I have made considerable effort to discover the reason for this, but so far without success. It is quite likely that the patent is void in the United States for the reason that the application was too long delayed, not having been filed here until 1894. There is a law that a foreign patent granted upon an application made more than one

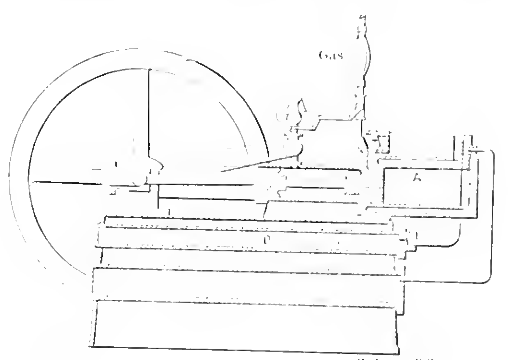


Fig. 1. Engine using Compressed Charge, Robson Patent.

year prior to the date upon which the application is made here, will act as a bar to the grant of a United States patent. And although the patent was secured, it would seem to have been issued contrary to law, and is therefore void. Quite a number of American manufacturers have been building these engines for several years, apparently without protest, and seem to regard it as a dead letter.

The Robson patent mentioned above as the first instance of a two-cycle engine using a compressed charge, is sufficiently shown here by Fig. 1. The cylinder is double acting, and the piston rod is supported by a crosshead as in steam engine practice. The front end of this cylinder is the air pump for preliminary compressing. There is a reservoir *B* in which the slightly compressed mixture of air and gas is stored, and delivered to the rear or power end of the cylinder, immediately after the exhaust, at the termination of each out stroke. The Benz patent, Figs. 2 and 3, is the same in principle as the foregoing, except that the engine stored and compressed pure air only, the gas being forced into the cylinder during the *last* half of the *compression* stroke by means of a gas pump driven from the crosshead, shown at *G* in Fig. 2. The inventor says in his specifications that this primary separation of the air and gas was effected to prevent the escape of the fresh gas through the exhaust valve. But if he had made a slight change in the adjustment of his gas pump, so as to admit the gas during the *first* half of the *power* stroke, he would virtual-

ly have made what we now know as the Diesel engine. This, however, will be discussed more at length in a future paper. In Fig. 3, E is a hollow bed plate in which the air is stored at a slight pressure by the action of the piston in the front end of the cylinder, as in the Robson engine, and I, in Fig. 2, is the valve through which the gas is driven into the cylinder by the gas pump G. The double-acting cylinder type in which the

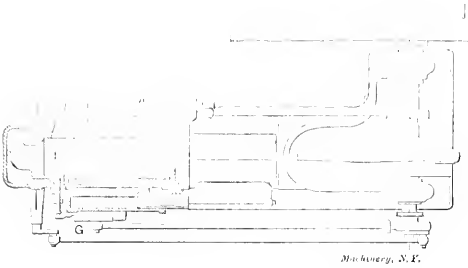


Fig. 2. Horizontal Section of Benz Engine, showing Gas Pump

front end is employed for preliminary compression, was once a great favorite with gas engine inventors, but has since been abandoned in favor of the inclosed crank case.

The L. H. Nash patent is illustrated here by Figs. 4 and 5. This patent embodies four important points, and furnishes an expired precedent for the following features: The inclosed crank case, air-jacketed cylinder and protected piston and

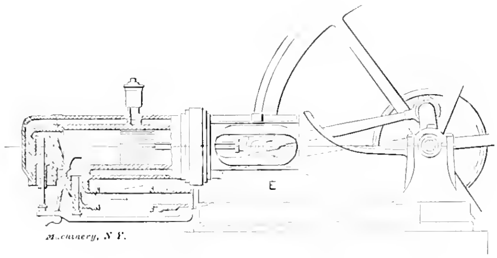


Fig. 3. Vertical Section through Benz Gas Engine.

splash lubrication, with a mixture of oil and water. In lieu of a jacket, the crank case of this engine has an upward extension which incloses the entire cylinder, leaving an annular space around it.

The bottom of the case forms a tank for the oil and water which is splashed about by the motion of the crank, lubricating the interior parts and being carried along to some extent

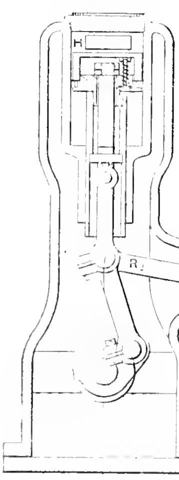


Fig. 4.

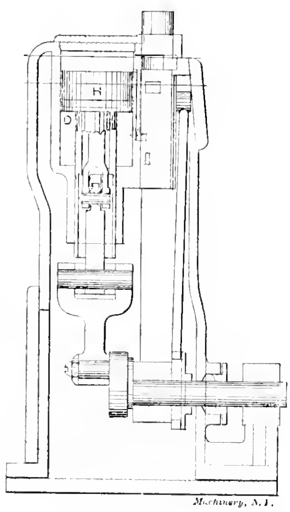


Fig. 5.

Fig. 4. Cross-section, and Fig. 5, Transverse Section of Nash Gas Engine.

also with the entering charge, and oiling the cylinder. The fresh air being constantly drawn into the crank case by the pumping action of the piston, circulates around the cylinder and forms the principal dependence for cooling, though in some cases assisted by the injection of a small amount of water. In regard to the piston, it may be noticed that the thick cap or protecting piece, H, is slightly smaller in diameter than the cylinder bore, and does not come into actual contact with the walls of the same. By reason of this cap or extension, the greatest heat is confined to the upper part of the cylinder, the ring D, working in the lower part where the walls are not exposed to the impingement of the flame, and are therefore somewhat cooler. This ring, too, is said to be made of a refractory material. This feature of the extended piston was subsequently more fully developed, and very successfully used in an engine which we will discuss at another time. The rod or link R_2 in this patent is a substitute for a crosshead, a device now entirely unnecessary. The engine was four cycle.

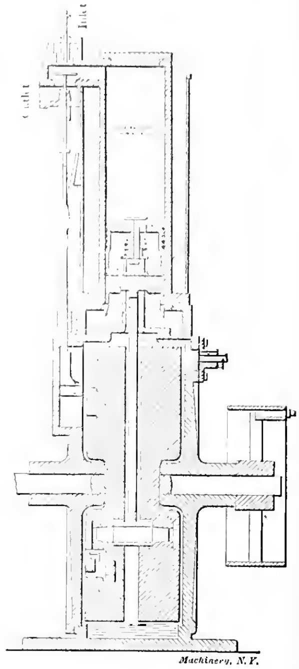


Fig 6. The Daimler Engine.

The Daimler patent is illustrated by Fig. 6. This famous invention contains several individual features, but is shown here only for the reason that it was the first instance in which the fly wheels were inclosed within the crank case, a method of construction which was followed up in France, and has become very popular here with builders of small automobile engines. It may be noted, also, that this engine used an ignition device which was equivalent to the now well-known hot tube, and seems to be the pioneer in this system of firing the charge. Pure air or a weak mixture was drawn into the crank case and admitted to the cylinder through a valve in the piston, the gas being drawn in separately. The object was to avoid preignition.

The Day patent, previously mentioned as being the first to use the closed crank-chamber as a compression cylinder, will be described among the patents reviewed in the next installment of this article.

* * *

The welfare work done by the National Cash Register Co.- Dayton, Ohio, is well known. For a number of years they have made it a practice to furnish a noon-day lunch to all their female workers, numbering between 500 and 600. The latest move is to build an enormous eating hall 100 feet wide and 328 feet long, which will accommodate 4,000 persons at luncheon at once. This building can also be used as an auditorium, in which capacity it will seat an audience of 6,000. This combined dining and lecture hall will be managed by the Men's Welfare League, an organization of workingmen of Dayton. It is expected that luncheons will be served to at least 3,000 people per day. The furniture and dishes are supplied by the company, and the league hires the help, purchases the supplies and serves the meals. Luncheons will be served for 15 cents each or 90 cents per week. This apparently is a move on the part of the company to relax something of its paternal attitude while at the same time to extending its welfare work. The men will manage the business themselves, and thus will not feel so much that they are the beneficiaries of a charitable provision.

HOW MACHINE TOOLS ARE SOLD.

A conversation between Mr. H. F. Frevert and the Publisher of MACHINERY that makes interesting reading. Mr. Frevert has had many years experience of trade conditions on both sides of the Atlantic, as Sales Manager for some of our largest manufacturers.

Q. Have conditions connected with the selling of machine tools changed during recent years? A. Not to any extent. Some years ago it was generally considered that the dealer or middleman was a necessary evil and in time could be eliminated, and many even thought that his days were numbered; but as the manufacturers of machine tools are more and more becoming specialists, confining themselves to the manufacture of one, or at least a few kinds of machines, it appears that they are more than ever before dependent on the dealer to aid them in marketing their product, and the manufacturers seem now to appreciate this, for they protect their dealers more than ever and in every way they can, by referring all inquiries and orders to the dealers representing them, and doing all they can to prevent one from encroaching on another's territory, going so far as refusing to ship machines sold by one dealer into another's territory, although this sometimes brings about curious complications. For instance, many of the larger buyers have factories in different states, with their main office in New York, where the buying is done, and although the order may be placed with a New York dealer the factory will not ship the machine if the point of delivery is in another dealer's territory. In a case of this kind the New York dealer usually explains matters to the factory and divides his commission with the dealer into whose territory the machine is shipped, and this is generally satisfactory. The New York dealer could of course have the machine shipped to New York or some point in his territory and then reshipped to his customer, and this is sometimes done, although the difference in the freight may not amount to as much as he would have to divide with the other dealer. This is considered "sharp practice" and not often resorted to by the best dealers and is not countenanced by the manufacturers.

Q. What about the cost of selling compared to that in other trades? A. Probably the most difficult problem the average machine tool manufacturer has to solve is the sale of his product at an expense that will leave him a fair profit. In almost every business the greatest expense is for getting in touch with the buyer—getting his confidence and booking his first order. After that, the subsequent orders are secured with comparatively little effort and expense, provided of course the article sold is satisfactory; but in the machinery business, with the exception of the railroad companies and a comparatively few large and growing manufacturers using metal-working tools, the majority of buyers are new customers, and after buying their first installation or outfit of machinery they may not require any new or additional tools for years. This is the case with the various mills and factories, who purchase a few tools to keep their own machinery in repair; and the average machine shop or manufacturer of articles requiring metal-working tools, unless they meet with unusual success and increase rapidly, buy a new machine only now and then, but not frequently enough to justify the manufacturer in keeping a representative in personal touch with them. This is partly due to the long life of machine tools, usually estimated at from twenty to twenty-five years.

Q. How important a factor is the work of a traveling salesman? A. A very important factor, I should say. In most mercantile lines manufacturers can and do keep traveling salesmen who visit at regular intervals not only the larger cities, but small towns as well, and find in each a number of jobbers or merchants dealing in their respective lines; but only in the larger cities will be found a machinery merchant, and those cities are few and far apart, making traveling between them expensive. There are very few, if any, manufacturers of machine tools in the United States who keep, or could afford to keep, traveling salesmen constantly on the road doing so-called missionary work; but most of them have traveling salesmen whom they send out on special inquiries. This is not surprising when we remember the long life of machine tools and that they are not consumed in the sense that pig iron, steel and other materials are. While it is true that there are machine shops and metal goods manufacturers in nearly all the large towns east of the Mississippi River, and also of course on the Pacific coast, a traveling salesman could not earn expenses for a manufacturer making only, say, shapers. He might visit a number of towns and not find a single shop then wanting a shaper, although a number of those called on might be in the market for a planer, a drill press or some other machine which his employer does not make.

Q. This, I judge, is where the local dealer steps in? A. Yes, and where he is of great assistance to the manufacturer; for although the dealer has but a small margin of profit compared to the manufacturer he can, in his limited territory, and with a variety of tools of different makes, and usually a line of supplies to sell, keep his traveling salesmen at less expense in contact with every buyer, with a very much better chance of securing an order for some kind of a machine or supplies than could the manufacturer's salesman who has but one kind of a machine to offer.

Q. What is the usual method followed by the average manufacturer to obtain business? A. To advertise in leading trade papers, to send out circulars and catalogues, and to arrange with some machinery dealer to represent him exclusively in the latter's territory, usually within a radius of three or four hundred miles. While this is no doubt the best arrangement that has been tried, it is not always satisfactory for several reasons. The dealer, especially in the smaller cities, may have the agency for two or more manufacturers of the same kind of tools, and in that case one or the other manufacturer is sure to feel that he is not getting the amount of business he feels he is entitled to, and there is no doubt that the machine having the greatest number of talking points, or the one that is advertised the most, or that is sold for the least money, is the one that is easiest to sell and has the greatest sale, for the salesman invariably takes the line of least resistance and will sell the machine for which his customer shows a preference, and the average salesman is not slow to note and fall in with the views of the buyer. The very fact that machinery dealers are required to sell a great variety of tools prevents them or their salesmen from being familiar with all the working details and the advantages of certain parts of the different machines and it is no doubt true that there are many tools sold daily that are not the best for the kind of work for which they are purchased. The salesman can hardly be an expert in these matters, although it would be to his advantage if he were; but it is surprising how little the average salesman knows in a mechanical way about the machines he sells. He usually gets hold of the "talking points" his machine has over others and talks them the best he knows how.

Q. Is there much cutting in prices done by dealers? A. Prices are usually maintained by dealers on machines for which they have the exclusive agency, except when bidding for the United States government orders or on large railroad or other equipments, in which cases a lump sum bid is usually made and prices cut considerably, frequently by the manufacturer making a special price for the occasion, and still further by the dealer cutting his commission. There is always more or less cutting of prices on machines that are in the open market; that is, machines for which there is no established agency, but that can be bought and sold by any dealer.

Q. When a customer calls at a store does he usually insist on buying some particular make of tool, or is it easy to switch him off on another make for which the dealer is the agent? A. Customers for machine tools are not different from the rest of human kind. Some know exactly what they want and insist on having it, while others can be influenced to buy what the seller has to offer. The majority of tool buyers are willing to listen to and investigate the claims of advantage made for different tools, and it depends entirely upon the salesman's ability to convince the customer that his machine is superior to others. If he can do so he usually secures the order, and it may be at a higher price than his competitor's. The average buyer, if convinced that a certain machine is superior or is better adapted for doing his particular class of work, will not let the matter of price stand in the way of obtaining it.

Q. What is the proportion of sales compared to the number of inquiries, or the number of quotations made? A. If you refer to quotations made by letter that are not followed by a personal interview with a salesman, the proportion of sales to the number of quotations is very small indeed, some estimates being placed as low as 10 per cent. A well-known machine tool manufacturer who was considered one of the smartest in the business, said some time ago he considered it time wasted to simply make a quotation by letter and not follow the quotation by sending a salesman to see the prospective buyer, and he usually consigned such inquiries to the waste basket. This shows how differently men feel about the best means of getting business. There is one of the New York machinery houses that depends almost entirely on the mail for their orders, although I understand their policy is to cut prices, which they can afford to do, as they save the expense of salesmen and traveling. By this means they get the reputation of selling goods cheap, and do a large volume of business, much of their business coming to them simply on account of this reputation.

Q. Where they get such a small percentage they of course do not handle the tools? A. There is probably not more than 25 per cent of the tools sold that are shipped from the store or warehouse of the dealer. Three quarters of them are shipped directly from the factories and are never seen by the dealer making the sale.

Q. Isn't a purchaser more likely to buy from a dealer than from a manufacturer, knowing that if there is anything wrong with the machine he is more sure of having it made right." A. Yes, most buyers prefer to purchase from the dealer, and why should they not? The dealer sells as low as the manufacturer, and often lower by cutting his commission, and will give better terms, while the manufacturer guarantees his machines whether bought direct or through a dealer, so the buyer has a double guarantee when buying from a dealer; and if anything is wrong he has the dealer to stand between him and the manufacturer and fight his battle for him. It is to the dealer's interest to have the matter adjusted to his customer's satisfaction, and the former is in a stronger position to force his claims (if need be) with the manufacturer than is the individual buyer.

Q. Isn't there quite a large profit on second-hand tools? A. It depends altogether on the buyer, his experience and knowledge of values and which tools are salable or not. When the country is prosperous and business good, there are but few second-hand tools to be had, nor is the demand for them as great as when business is dull—then the supply is increased by failures in business and by factories getting rid of tools they have no further use for. The demand then is also greater, no doubt because the buyers don't feel prosperous and want to save every dollar they can.

Q. Are many new tools sold and part payment taken in second-hands? A. Very often.

Q. If a concern wants to buy a large tool that will, for instance, replace a lot of lathes, doesn't the dealer often have to take those lathes in part payment? A. That is often the case.

Q. And for that reason isn't it more difficult for a manufacturer to market his product because a dealer can take such tools in part payment, having a market for them; whereas, the manufacturer has no way of disposing of them. In fact, he wouldn't know what they were worth? A. Yes, there are few, if any, manufacturers, who will take second-hand tools in exchange for new ones. They have no means of marketing them. This, again, is where the dealer is of great assistance to the manufacturer.

Q. How is advance information acquired of the building of new shops and the requirements of manufacturers in general? Is there any systematic effort to get that information made by concerns who have salesmen on the road? A. Such information is usually obtained in a number of ways. Very often from the trade papers and through the dealer's friends in the trade; but more often from the inquiries that come in direct to concerns who advertise.

Q. But wouldn't it pay a dealer to have his men stay long enough in each place to collect information in regard to anything new—I mean to do it systematically? A. They very often do that, and a bright salesman will always inquire in every town he is in regarding new enterprises or factories, and will call and keep track of them, but beyond this and writing letters and sending circulars to various new companies mentioned in the trade papers, I do not know of any systematic effort made by any house to collect information.

Q. What about the number of salesmen employed in the larger houses here? A. Compared with other commercial lines there are not a great many. I don't think there is any machinery house that has more than six or eight salesmen in any one city.

Q. What about selling railway shop tools? A. When railways are in the market they usually send out a list of machines wanted to the different dealers and manufacturers and ask for bids.

Q. Government work the same? A. Yes.

Q. Why is it that some concerns can sell so much more to railways and government shops than others? Why is it that manufacturers generally cannot? A. The railway companies usually prefer to place their orders with one concern for the complete outfit, and as only the larger houses are in a position to carry these large accounts they make the greater efforts to obtain and hold the railroad trade. Such houses can afford to book a large order at a smaller margin of profit than can the average dealer or individual manufacturer who has only a few of the tools to sell.

Q. Isn't government and railway trade considered very desirable by a good many people? A. I don't believe the government trade is considered by many to be worth the trouble it takes to get. They usually have to cut prices so there isn't much profit in it, and wait a long time for payment; and the government is very strict in its requirements. In the first place it is considerable trouble to make out the bids and furnish bonds, and the tools have to be delivered within a given time. If they do not arrive within the time specified, the government charges one fifth of one per cent of the amount bid for each day's delay, although the delay may be the fault of the transportation company or causes over which the dealer has no control.

Q. Does entertaining amount to much in railway sales? A. Yes, it does with some people, and there is more or less of it done.

Q. There must be many purchasing agents who won't accept favors of this kind? A. It isn't always the purchasing agent who is the one to reckon with; it is very often the master mechanic, the superintendent, or the man into whose hands the tool finally comes. The master mechanic or superintendent is the one who sends in the requisitions to the purchasing agent for the tools he wants.

Q. Is the sending out of circulars an important factor in the dealer's advertising scheme? Does any one send out circulars systematically? A. Yes, they all do.

Q. A good many send out second-hand lists? A. Most of them, but not at stated intervals. They are sent out spasmodically, depending on the stock on hand.

Q. If dealers have an inquiry for a tool do they try to work a second-hand off? A. As a rule they do not offer a second-hand tool if a new one is asked for, provided they have a new one to offer.

Q. Isn't it exceedingly difficult to get good machinery salesmen? A. Yes.

Q. What does their pay average; minimum and maximum? A. I knew salesmen who work for $15 a week; the average is probably $1,800 per year. I know one salesman who made $17,000 a year. The salary depends altogether on the amount of goods a man can sell.

Q. Do they usually work on salary or commission? A. Lower priced salesmen generally on salary. The $17,000 man worked on a salary and commission. It depends largely on the class of tools; on the large tools the percentage of commission is small, but the sales run into large amounts.

Q. How do manufacturers of special machines market their product? A. Most of them have their own travelers who cover the country thoroughly, and solicit and sell direct to the user.

Q. Why does this pay such manufacturers when it wouldn't pay the ordinary machine tool builder? A. For the reason

that special tools are sold at higher prices, for it costs the manufacturer more to sell them than when sold through dealers; but this is taken into account and the selling price is fixed accordingly. These special tools require trained men who are able to demonstrate just what the machines will do, and they cannot depend on the dealers to dispose of them.

Q. Is it customary to send men out to operate a machine tool? A. Not except in the case of special machines, and I think there are only a few manufacturers in the tool line who send men out without charge to instruct the operators how to obtain the best results.

Q. Does that pay, in your opinion? A. I think it is money well spent. For instance, a large concern in Pennsylvania bought two special machines. They were asked if they wanted an instructor at $3.50 per day and expenses, and they said: No; they had capable men who could run them. They set the machines up all right and then wrote that one wasn't doing satisfactory work of a certain class, and wanted to know what to do about it. The manufacturer replied that the machines were all right, and suggested that possibly the operator wasn't familiar with that kind of work, and offered to send a man there to give them instruction. They said they didn't feel like paying $3.50 a day and expenses, but the manufacturer happened to have a man coming home from the West and told him to stop over for a day or two and give them instructions, which made everything all right. Now, if they had refused to let that man go there (they wouldn't have sent for him), that machine probably never would have been satisfactory on that kind of work, and they would have blamed the machine. One company I know will send a man at their own expense with their machine to any place in the United States to stay with the new operator a week, or as long as necessary; and it's money well spent, because the operators get to know the best the machine will do. Then, too, the maker's representative can show the maximum that can be done on the machine, and that puts it up to the workman himself to get as much out of the machine, so when there is another machine needed the same manufacturer is sure to get the order. It is better to charge this right into the price of the machine and send a man.

Q. Then, don't you come right up against competition and find the price is too high, compared with manufacturers who don't do that? A. The matter of price doesn't count if you have talking points which will convince a purchaser and demonstrate that the machine is better than any other he can buy, and that he will get more for his money.

Q. Is a dealer often called on to furnish an estimate for the complete equipment of a shop, and asked to advise the customer what he ought to have, or does the customer usually hand out the list and say, "I want a price on this"; because a dealer ought to be able through his experience to save a customer a lot of money? A. Yes, he is often asked to estimate on a complete equipment, but not for advice as to what ought to be bought; because a buyer usually has his own mechanical man if he himself is not a mechanic, and he is so familiar with the work he is going to do that he usually decides on the machines he wants, and a great many salesmen often lose an order by trying to tell a mechanic that he ought to have a certain kind of a machine for a job. We all think we know our business best, and if one tells a man that isn't the machine he wants, but that he needs so and so, he takes it as a reflection on his intelligence. He generally thinks he knows better than the salesman.

Q. But he is not so likely to be familiar with the latest types of machines for doing certain work as a salesman is; and wouldn't the latter be qualified to offer advice that would be of value to the buyer? A. He ought to, but I don't believe the majority of salesmen are practical men, and where they sell such a variety of tools they can't become familiar with the details of each machine, as can the representative of the concern that makes that particular machine a study. That is where the firm I referred to has the advantage. They send out men that sell that one machine and nothing else. They are trained and practical men who can take a piece of work and figure out the time it would take to finish that piece in almost any shape you want it. That is something the ordinary salesman can't do.

Q. Is the social factor important in business—treating, etc. A. I think it is, but not as much as it used to be; not as important as most young salesmen imagine it is. I think they blow in a great deal more than is necessary.

Q. It is said of a large Eastern concern noted for their conservatism that when a reduction has been made in the price of one of their tools, they send a check for the difference to every customer who has bought one of those tools within thirty days. Is this a fact? A. Yes, I have been told so. I have had men say to me that they felt perfectly safe in ordering a machine from the concern referred to without asking the price, and I don't know any other concern in the United States that bears this reputation, although there are doubtless others that are entitled to it.

Q. Is there much difference in the price between the standard machine tools of the different makes? A. Very little. For instance, on 14-inch lathes, I don't believe the price on any of them will vary more than ten or fifteen per cent, leaving out two or three high-priced ones who get about one-third more than other manufacturers do.

Q. To what extent is the purchase of a tool influenced by the practical man in the shop? A. Usually the practical man decides what tool is to be bought. Most buyers leave that to the mechanical man. Certainly any wise one would.

Q. To what extent do features like gear drives, feed boxes, etc., assist in selling tools? A. They assist very materially; they are talking points, and the more you get of them, whether valuable or not, the easier it is to sell. You want talking points.

* * *

TURBINE BLADES.

In a paper on the construction of turbines read to the Institution of Engineers and Shipbuilders in Scotland recently by Mr. E. M. Speakman, it was stated that the material of which blades are usually made is a mixture of cheap brass containing 16 per cent of copper and 3 per cent of tin. Alloys containing zinc are extremely unreliable for high temperatures, but blades containing about 98 per cent of copper have been found very satisfactory for use with high superheats. More recently a material containing about 80 per cent of copper and 20 per cent of nickel has been adopted, and this is undoubtedly the best blading material existing. Steel blading, drawn in the same way as the usual brass section, has been used in the United States with fairly good results.. The process of drawing turbine blades gives an extremely tough skin to the metal used, not only increasing the tensile strength, but greatly decreasing the chances of erosion. It seems probable that the usual caulking piece now adopted will be discarded in favor of a machine-divided strip into which the blades may be fitted, and instead of the slotting, wiring, lacing and soldering process at the tip, a similar machine-divided shroud will be used. This will give a far stronger construction and will enable finer clearances and better workmanship to be obtained, at the same time considerably reducing the cost of manufacture and the risk of blade stripping. The chief causes of the latter may be set down to bad workmanship in fixing the blades, defective blade material, excessive cylinder distortion—this probably the most fruitful cause and a serious one, being due to bad design—whipping of turbine spindles (also due to bad design or bad balancing), wear of bearings, which is very remote, and the introduction of extraneous substances such as water or grit. In fact, blade stripping may be said to occur generally from preventible causes. Small vibrations of very high frequency occasionally set up an action in certain rows of responsive length that fatigue the blade material and cause the loss of blades without any fouling at all.—*London Times Engineering Supplement.*

* * *

MOTOR CARS IN WALES.

The country of Glamorgan, in South Wales, is one network of steam railways, whose principal business is the handling of coals to the seaboard. These systems, together with the rigid regulations of railway crossings in Great Britain, make the introduction of electric interurban trains impracticable; but inasmuch as the country had a population of 860,022 in 1901, it has become necessary to improve upon the old methods of

handling the passenger traffic, and for that purpose the steam motor car has been introduced in several places as a substitute for the electric tram. About a year ago the Alexandria Docks and Railway Company placed one of these cars on their line between Caerphilly and Pontypridd, and the experiment proved so satisfactory that a second car was placed on the same line September 28. This car, which is described as being 64 feet 11 inches in length and weighing 35 tons, is the finest yet put upon the railways in this country. Steam is generated in a

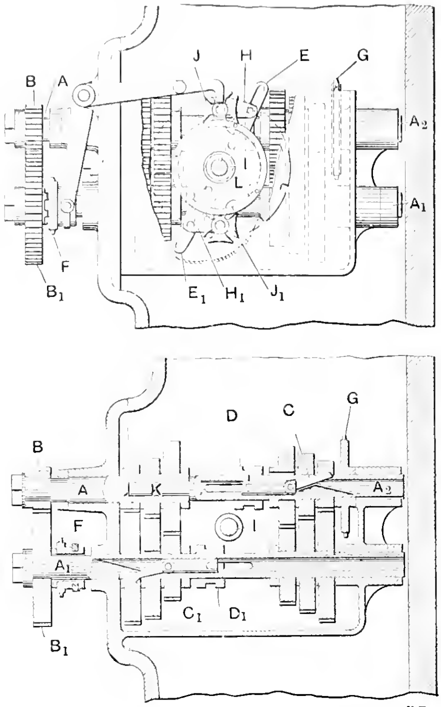


Fig. 65. Device Patented by E. J. McClellan, Jan. 9, 1900, No. 641,219.

locomotive type of boiler, which is fitted with Drummond water tubes. The cylinders are fixed on the outside of the bogie frame plates, and the water tanks, containing 350 gallons, and coal bunkers, having a capacity of 1 ton, are placed on each side of the boiler and are carried on the underframe of the carriage. The steam regulator and reversing gear are worked from either end of the car, so that the driver has at all times a clear lookout in the direction in which the car is traveling. In addition to steam brakes, powerful hand brakes are fitted to the wheels of each of the two bogies upon which the car is carried.

There is seating accommodation for 54 passengers. The seats, which are placed longitudinally, are plaited rush matting over springs. Passengers enter by a sliding door from a vestibule at the rear end, and, in addition, doors are placed on each side of the carriage to facilitate expedition when dealing with heavy traffic. Electricity, generated by a De Laval steam turbine dynamo placed on the footplate, is used for lighting the car. Numerous substations have been established for the accommodation of passengers, just as in the case of interurban electric trams, and the service seems very acceptable.

* * *

In order to appropriately celebrate the completion of the Simplon Tunnel, an international exposition will be held in Milan, Italy, from May to November, 1906. It is expected to be the largest European exposition ever held outside of Paris. The prominent feature of the exposition will be that processes of manufacture will be shown wherever possible. In short, the machinery will in general be in motion, thus making a large part of the show live exhibits. Intending United States exhibitors may obtain further information from J. H. Gore, George Washington University, Washington, D. C.

VARIABLE SPEED MECHANISMS.—7.

GEARED DEVICES. (Continued.)

Fig. 65 shows a typical combination of gearing for effecting speed or feed changes in machine tools without the necessity of stopping the machine or without the need of inspection on the part of the operator of the position of the locking members. This device was patented by E. J. McClellan, January 9, 1900, No. 641,219. There are four sets of spur gears of varying pitch diameters arranged so that their pitch diameters increase in order, thus forming the so-called cones of gears. These cones are mounted on two parallel shafts, A_1, and the compound shaft, A and A_2. Each shaft has one set of gears mounted solidly thereon, but the other set of gears is mounted loosely on the shaft and connection thereto is made by means of sliding feathers C C_1. These feathers are controlled by clutch collars D D_1, which in turn are connected to the operating levers E E_1, shown in the upper view. These levers are mounted on a common pivot, but are independent in action. The problem of shifting the keys by a simple hand motion so as to get all the possible combinations in geometrical series is a somewhat difficult one, and is ingeniously effected in this device. It makes use of the Geneva stop motion by which

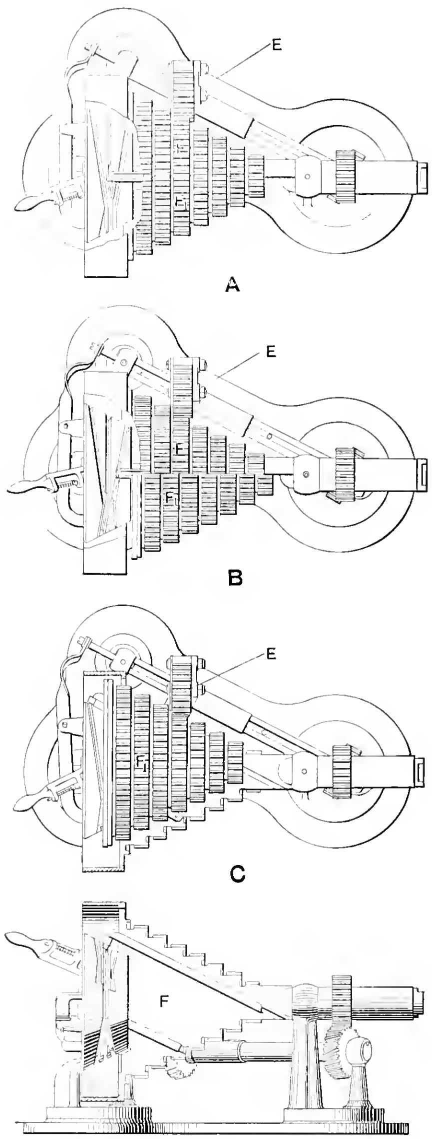


Fig. 66. W. P. Shattuck's Patent, Sept. 10, 1901, No. 682,391.

the sliding feathers are alternately slid back and forth to engage the respective gears necessary to transmit the required ratio. The levers E E_1 carry pins which engage the grooves in the collars D D_1 and on the opposite face they are slotted. In these slots work crank-pins in cranks H H_1, which are attached to the Geneva disks J J_1. It will be noticed that the half of one step is brought into osculation with the pitch diameter of its neighbor so that the pinion E will roll off from one step and start onto the next without shock, and as the cone turns around the half which has been displaced is returned to its normal position so that when the cone has revolved 180 degrees the new speed is taken up smoothly. The

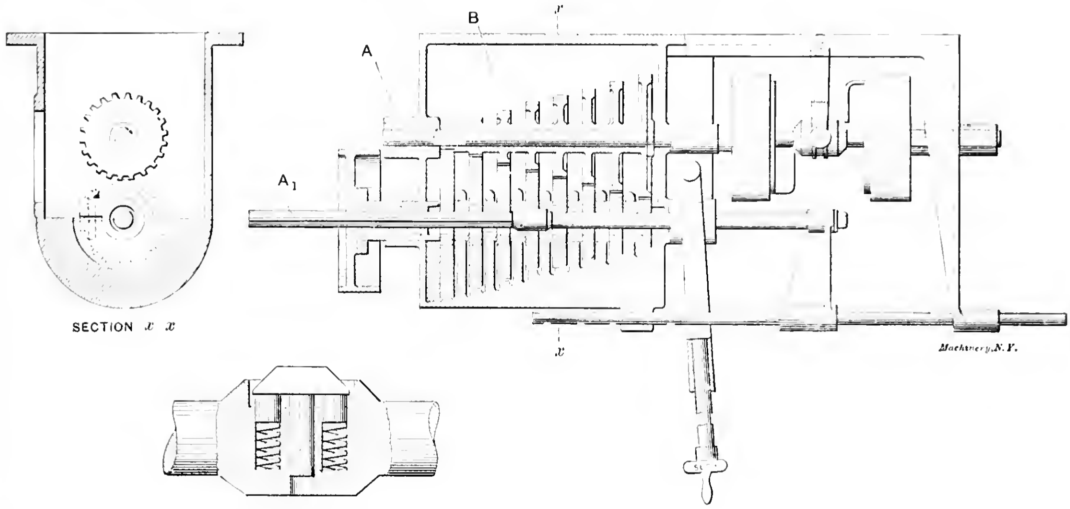


Fig. 67. Patent No. 683,003, granted to W. L. Schellenbach, September 17, 1901.

upper shaft is in two parts, the right-hand part A_2 being reduced at K and fitted to a hole bored in the other part A. Motion is communicated by sprocket F through B and B_1 which are change gears and thence through the gear cones to shaft A_2 and sprocket G. When speed changes are to be made the bellcrank lever must be lifted to unlock the disk and this motion throws out the clutch F.

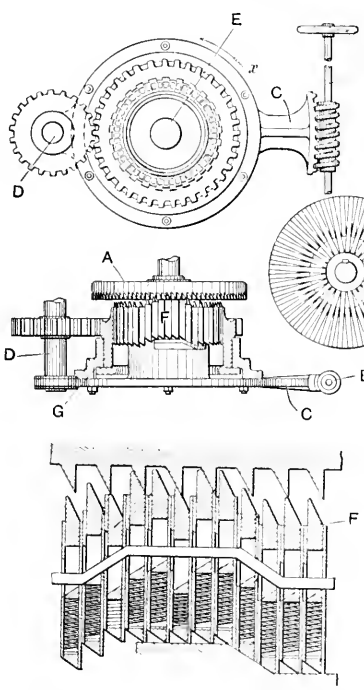


Fig. 68. An Arrangement proposed by I. J. Foccart for use on Automobiles, Patent granted Dec. 30, 1902, No. 716,881.

W. B. Shattuck employs a bold scheme for effecting speed change. This device, illustrated in patent No. 682,391, granted September 10, 1901, consists of a cone of gears which are split longitudinally and are tongued and grooved so one half of the cone F is shifted on the other on a line parallel with one side of the cone. In this manner the pitch circle of one

diagrams are practically self-explanatory, so far as the principle is concerned, so it is not necessary to enter into a detailed description of the somewhat complicated device by which these changes are effected at the critical periods without disaster.

Patent No. 683,003 was granted to W. L. Schellenbach, September 17, 1901, for a variable-speed mechanism of the countershaft type. In this invention two shafts A A_1 are arranged parallel, one being the driver and the other the driven. On shaft A is placed as many spur gears as there are speed changes required. The corresponding gears on shaft A_1 are made with large bores in the hubs, and normally all the gears are out of engagement with the driving gears, save the one which is actually transmitting motion to the driven shaft. This gear is raised into engagement by means of a collar B

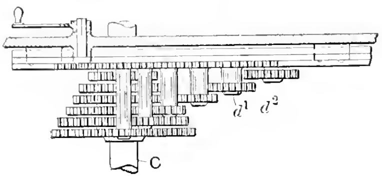
Fig. 69. Patent No. 727,404, granted to J. Mills, May 5, 1903.

secured to the sliding shaft A_1. This collar is provided with a spring key, as shown in an enlarged view in Fig. 67, which springs into place into a keyway provided, as the gear turns around. The idle gears do not hang upon the rotating shaft but are supported at the bottom by the enclosing case. A feature of this device is that in changing from low to high speed or *vice versa* all the intermediate gears must successively be put into motion so that the change is made progressively and without the shock that would otherwise result.

In Fig. 68 we have a speed change apparatus patented by I. J. Foccart, December 30, 1902, No. 716,881, for use on automobiles. This is one of the few attempts to produce a positive-geared speed variator in which speed changes can be made by imperceptible gradations from the highest to the lowest speed. A plan view of the apparatus is shown in the upper cut and a side view and face view of disk A under-

neath. The lower view shows a section of the teeth enlarged. Change of speed is effected by the screw and handwheel *B*, which shifts the plate *C*. This turns on the pivot *D*, thus changing the position of center *E* with the center of the driver *A*. Radial teeth are cut in the lower face *A* in which engage the peculiar tooth carriers *F*, which are supported in the gear *G*. At one point these tooth carriers are lifted above the normal plane to engage the radial teeth in the face of *A*. To compensate for the lack of uniformity of tooth spacing and width in *A*, the tooth carriers are made with spring plungers that collapse and adjust themselves to the required height to engage properly with the radial teeth faces. It is scarcely necessary to remark that there is an almost total lack of proper teeth action and that such a device must necessarily be quite impractical for any purpose where any but very moderate power is transmitted. That the idea might not be worked out into practical form is not impossible, however.

The speed-changing mechanism for machine tools shown in Fig. 69 was patented by J. Mills, May 5, 1903, No. 727,404. In this device a multiplicity of spur pinions *C* is mounted on a hub with the toothed wheel *A*. The hub is mounted on a shaft *B* carrying a long pinion which meshes with each of the gears *C*, etc. Shaft B is the driver and all the intermediate gears run constantly, in the scheme shown although this is not a necessary feature of the device. Parallel to the shaft *B* is another shaft *E* on which are mounted the gears *F* of varying dimensions. The rotation of the toothed wheel *A* by means of a pinion and hand lever brings anyone of the desired intermediate pinions *C* in mesh with one of the gears *F*, and



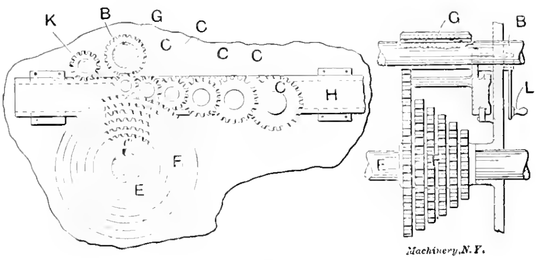


Fig. 70. A Modification of the Idea shown in Fig. 69.

thus effects the desired speed change. This device has been successfully applied to shapers, and speed changes are readily made without stopping the machine. Although in the drawing shown all the gears *C* are in mesh with the pinion *G*, an alternative plan and one employed in practice is to make the hub *A* eccentric to shaft *B* so that only the desired intermediate gear is running, the others remaining stationary since they are thrown out of mesh. In the same patent specifications the inventor shows the intermediate gears arranged on a rack bar in which case rectilinear motion is necessary to effect the desired speed changes. In this device, Fig. 70, the intermediate gears *C* are carried on a rack bar *H*, which is shifted by the pinion *K* and hand lever *L*. The driving gear is *G* and the intermediates convey its moton to any one of the cone of gears *F*, selected.

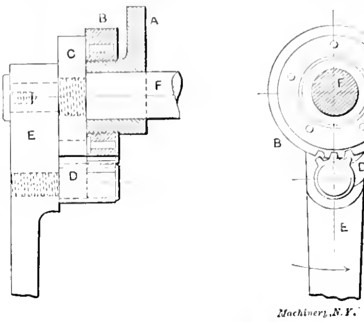
* * *

Krupp's works at Essen find employment for some 55,816 hands. Overtime is at present being worked in the gun factories two or three days a week. In the hammer and roller works double gangs have been introduced throughout, and the number of men has been increased. The orders for war material are so enormous, and promise to attain such proportions, that the construction of a new large gun shop is being contemplated.—*Mechanical Engineer.*

This does not appear much like the immediate era of universal peace.—EDITOR.

NON-RETURN STARTING CRANK FOR GAS ENGINES.

A novel and ingenious safety starting crank brought out in France, is described by *La Vie Automobile*, and translated by the *English Mechanic*. Referring to the two views of the device herewith, *A* is a bracket fixed to the front cross member of the frame, in which the end of the crankshaft *F* has a bearing. Upon the hub of this bracket is located a roller clutch or free-wheel arrangement *B*, the inner part of which is fixed to the bracket so that the outer part can only turn in one direction (left-handedly in the plan view herewith, which shows the device from the back or motor side). The periphery of the free-wheel *B* is cut with a number of gear teeth



A Non-return Starting Crank.

with which mesh corresponding teeth on the hub of the pawl *D* pivoted on the crank *E*, which is mounted loosely on the end of the crankshaft *F*. The pawl *D* is adapted to engage into sawtooth notches on the disk *C* fastened upon the end of the crankshaft. The action is as follows: Suppose the engine is to be started and the starting crank is turned left-handedly (in the drawing) to accomplish this. Owing to the slight friction of the free-wheel *B*, it will not commence turning at once, but will remain stationary, and owing to its teeth meshing with those of the pawl *D*, the latter will be swung about its pivot and engage into one of the four notches on disk *C*. There is then a positive driving connection between the starting crank and the engine-shaft, and the engine can be started in the usual way.

Now suppose that while the operator is pulling on the starting crank a back explosion occurs, which moves the crankshaft back against his pull. The free-wheel *B* cannot move backward (right-handedly in the drawing), and its teeth cause the pawl *D* to move on its pivot like a planetary pinion, thereby becoming disengaged from the notches in the disk *C*, and freeing the starting crank. The device is made by Breviaire and Kenel, 49, Boulevard Gouvion-Saint Cyr, Paris.

* * *

We commonly regard a second as a very brief interval of time, but in instantaneous photography it is often a measure of enormous extent, especially for some of the work done in the laboratory. For example, Prof. Brown showed in the course of his lecture on the photography of invisible phenomena, given before the A. S. M. E., December 6, a photograph of a falling drop of water made with an exposure of 1-10,000 second. In such work a shutter is not used but the object is illuminated by a flash, being in this case the explosion of a thin glass bell filled with oxygen and hydrogen gases in the proportion H_2O. So rapid is the combustion that the whole mass in a small bell is fired before the thin glass walls (thinner than writing paper) can yield perceptibly. Exposures of far less duration are made with electric sparks by charging a Leyden jar with a spark and using the secondary spark for illumination, it being possible in this manner to get exposures of an estimated period of 1-1,000,000 second!

* * *

On account of the great number of calculations necessary in compilation of some of our data sheets, it is impossible for the editors to check all the values given. For this reason we should esteem it a favor that we be informed of any errors that are found so that they may be corrected in future reprints.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

For obtaining the side of a square which shall be equal in area to a given circle, the empirical method, devised by Ahmes and described in the Rhind papyrus, 4,000 years ago, is very simple and sufficiently accurate for many practical purposes. The rule is: Cut off one-ninth of the diameter and construct a square upon the remainder. This makes the ratio of the square of the radius to the area 3.16, and the error does not exceed two-thirds of one per cent.—*The Practical Carpenter.*

An Italian engineer, Signor Jelpo, has invented a submarine elevator for raising wrecked vessels. The invention was recently put to a practical test, with complete success, in the bay of Naples, where a stone-laden barge, sunk a couple of years ago, and lying at a depth of about 50 feet, was brought to the surface with ease. The weight lifted was about 60 tons. The apparatus consists of compressed air chambers of canvas and wire, each having a lifting capacity of 60 tons, and it is possible to attach as many of these as may be necessary, after calculating the weight to be lifted.

One of the interesting exhibits at the American Railway Appliance exposition held in Washington in connection with the recent International Railway Congress, was a new process for quickly obtaining a temperature of 1,000 to 1,100 degrees F. The substance is called "calorium" and is ignited with a match giving a double chemical reaction. The purpose for which it was exhibited was the soldering of railroad bonds. By the use of calorium the ends of the rails were quickly raised to a dull red, melting the solder on the bond terminals and uniting them permanently to the steel, thus making a perfect electrical bond.

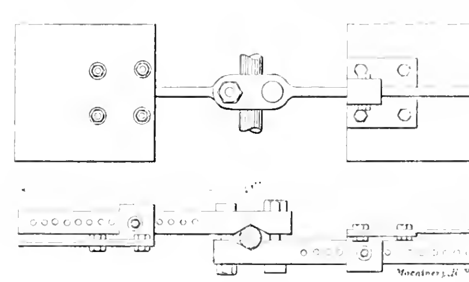
An opportunity was afforded a few weeks ago to test the destructive action of a large quantity of dynamite on the banks of a ship canal. The steamer *Chatham* took fire in passing through the Suez Canal and had to be scuttled. The cargo included 85 tons of dynamite and a quantity of nitroglycerine. It was not practicable to salvage the cargo and raise the steamer so she was blown up September 27. Considerable damage was expected but contrary to the expectations, it was comparatively small. This fact is interesting inasmuch as it has been frequently declared that our Panama Canal might in time of war be rendered useless by the explosion of a comparatively small quantity of dynamite in a lock or other strategical position. It would appear from the result of the explosion of the *Chatham* that the possibility of great damage being caused in this manner is remote, with the quantity of high explosive that could be smuggled into such a place in war time.

A patternmaker with some experience, in the neighborhood of government headquarters, writes as follows: "There are no private firms making patterns in Washington, D. C. All of us (patternmakers) are employed by the government. There is nothing for us outside of that. They have finished the new pattern shop and it is up-to-date in every respect—all individual electric motors to the machines, dust pipes, etc. The patterns are commonly made of mahogany. They are examined by naval officers and are made to the one-hundredth part of an inch. This is unnecessary, but is done with every pattern. The patterns are varnished a light color with the core-prints black. They must be beautifully finished, in general appearance as well as to accurate dimensions. No leather fillets are used. The webs must be rabbetted in wide enough to work the fillets from the solid and have the joints perfect. Neither brad holes nor brads can show in the patterns. If the strain will be too great for glue to hold the parts in place, screws must be used. These screws are countersunk for wood plugs. The wood plugs are inserted in the countersunk holes over the screws, the grain of the wood in the plugs running the same as in the surrounding surface of the pattern. This practice is quite different to some of the hurry up, putty up, jobs I have seen elsewhere. All work is done on the eight-hour day plan."—*Wood Craft.*

The transmutation of the baser metals into gold or silver was the alchemist's dream, and whether the possibility exists or not, the fact remains that these ancient cranks did much to develop the modern science of chemistry. With the widening of vision due to recent discoveries which seem to indicate the possibility that the so-called elemental substances can be divided or resolved into new forms, the ambition of these ancient workers does not seem quite so absurd. We are already able to make diamonds, minute, it is true, but the fact that carbon can be changed into the crystalline form characterizing the diamond shows that there is the possibility of making these precious gems of commercial value. A recent report by Consul-General Guenther of Frankfort, Germany, reviews what has already been done by the French chemist Moissan and mentions the recent interesting experiments of Dr. Burton of Cambridge. Dr. Burton's experiments seem to indicate that perhaps high temperature is not so necessary as a high pressure under which the peculiar crystallization takes place from a yet unknown solvent. Dr. Burton in his experiments used a molten alloy of lead and metallic calcium which held a small quantity of carbon in solution. The separating of the calcium by means of steam introduced at a low red heat caused the formation of small crystals, having properties identical with those of natural diamonds, whereas at a high red heat graphite was formed. The fact that extremely high temperature is not necessary appears to simplify the problem somewhat.

A FAN AS AN ABSORPTION DYNAMOMETER.

The use of a fan as a power-absorption apparatus is no great novelty for loading steam engines, but the extension of the idea so as to measure the power absorbed is interesting, if not distinctly novel. The *Practical Engineer* in a recent issue describes a dynamometer of the fan type, which is the design of Mr. W. G. Walker, Emery Hill, Westminster, England. The apparatus consists of a pair of vanes which are clamped upon the engine shaft, with means provided for adjusting the vanes radially on the arms. The size described is suitable for powers ranging from ¼ to 26 horse power and for speeds from 250 to 2,000 revolutions per minute. The length of the arms over all is 21 inches, and three sizes of vanes are provided. The



device is calibrated for all speeds up to 2,000 per minute, and the power absorbed at different speeds and with different sets of vanes is recorded. It is used by clamping the arms upon the shaft, adjusting the vanes and then running the steam, gas, electric and other motor up to its working speed and load. Then, knowing the speed, and the position and size of the vanes, the horse power is known from the tabulated laboratory tests which are given out with each dynamometer. The advantages of the device for small powers are that the apparatus is much simpler than a Prony brake, the heat is absorbed and dissipated by the atmosphere, and the torque automatically increases with the speed; a disadvantage is that

the load cannot be adjusted for a given speed without stopping the meter. The only apparatus necessary besides the vanes are a revolution counter and a time piece.

THE TEMPERATURE OF FLAME.

In a paper on the temperature of flame read by Mr. Arthur Smithells before the Institute of Gas Engineers he spoke of the uncertainty of what is meant by the temperature of a flame. Where gas is burning in the usual matter by allowing it to flow into the atmosphere without previous mixture with air the flame consists usually of thin shells of combustion which vary in temperature. In the middle of the flame there may be a temperature not very greatly above that of the surrounding air and at the edges of the flame, not more than one-fourth inch away, the temperature may be above the melting point of platinum. It is therefore obviously absurd to attempt to measure by ordinary means, as for example a glass thermometer, for such an experiment would be subjected to a variety of conditions and could not possibly be an accurate index of what the maximum flame temperature is. The author then alluded to the method employed by Prof. Fery which is based upon the reversal of the D line of sodium vapor when viewed against an electric filament of known and alterable temperature. By this method Fery estimates the temperature of the electric arc to be 3,760 degrees C. (or 6,800 degrees F.) and that of the sun to be 7,800 degrees C. (14,000 degrees F.). The following is a table of maximum flame temperatures as determined by Fery, and published in 1904:

	Deg. C.	Deg. F.
Bunsen burner, gas fully aerated	1,871	3,400
Bunsen burner, insufficient air	1,112	3,114
Acetylene flame	2,548	4,618
Alcohol flame	1,705	3,101
Denayrouze Bunsen, alcohol and air	1,862	3,384
Denayrouze Bunsen, ½ each alcohol and petroleum spirit	2,053	3,727
Hydrogen, free flame in air	1,900	3,452
Oxy-coal gas blowpipe flame	2,200	3,992
Oxy-hydrogen blowpipe flame	2,420	4,388

LOSS OF VELOCITY RATIO DUE TO BELT ELASTICITY.

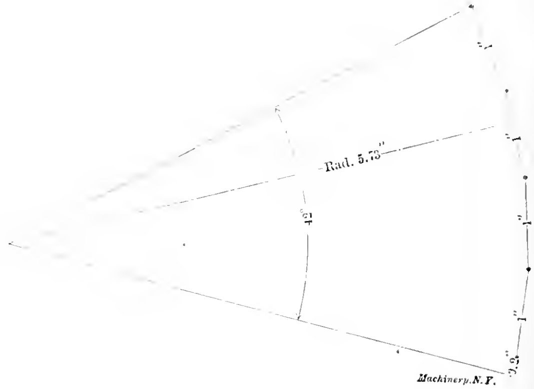
An interesting condition met with in belt driving is referred to by the *Practical Engineer*, and that is the difference in velocity ratio other than that due to the difference in diameters, which may exist between two pulleys when the driving belt is elastic. It is usual to assume that the number of revolutions for two shafts connected by a belt is inversely as the diameters of both driver and driven pulleys, and for most purposes it is quite safe to accept it as such, although strictly speaking, not quite true. When a belt is doing work, the tight or working side will be constantly stretching, considerably more than the slack side, the amount of stretch depending upon the elasticity of the belt and the working tension brought upon it. Consequently the pulley and shaft which are being driven will fall behind in speed by an amount equal to the creep of the belt. It has been shown that by using a very elastic belt the driven shaft was made to run at about half the speed of the driving shaft, although both pulleys were practically of the same diameter.

This proposition is interesting in a number of ways; it suggests the possibility of varying the speed of the driven pulley by manipulating the tension of the belt. For example, suppose the belt was in the nature of a coiled spring, the extension of the spring would depend upon the tension and this in turn, as pointed out, would affect the ratio of driver and driven pulley speed. Now, it would be possible to limit the extension of the coil spring by means of a chain arrangement inside the coil, and this would have the effect of definitely fixing the amount of extension. Such an arrangement, however, would be of little practical value, but applying it in another manner, as for the purpose of illustration, making a flat belt with a series of cross cuts, so arranged that as it was stretched the cuts would assume a diamond shape, we would have a condition by which the extension of the belt might be controlled and that is, by providing guides at the sides of the belt where it leaves the pulleys, which would engage flanges attached thereto and thus prevent the extension going beyond a pre-determined limit. The amount of extension could thus be changed while in operation and the velocity ratio brought under control of the operator. The slack side of the belt would have to be taken care of by an idler pulley.

The fact that belt creep can be so great as to allow a driven pulley to fall 50 per cent behind its theoretical velocity is important, as it has a direct bearing upon the working of high-speed internal grinders, especially those having rubber bands for driving. It is doubtful if some of the high-speed grinding wheels run at the calculated velocity which, being so, would often account for poor working.

TO LAY OFF AN ANGLE WITH SCALE AND DIVIDERS.

A useful method of laying off angles with dividers and scale is described by an English engineering publication, and although it is approximate in its results it should be accurate enough for many purposes. Set the dividers to a radius of 5.73 inches and describe an arc of indefinite length. On this arc lay off the desired angular measurement, making each degree equal 0.1 inch on the arc. Of course each degree is not stepped off but the arc should be stepped off in small multiples in order to more closely approximate the linear measurement to the arc. For example, suppose an angle of 42 degrees



is wanted; it may be laid off as shown in the accompanying cut. After striking the arc with a radins of 5.73 inches set the dividers to 1 inch (10 degrees) and step off four places. Then set them to 0.2 inch (2 degrees) and step off one space to complete the measurement. It will be noticed that 5.73 inches is nearly 5¾ inches and this radius will give, perhaps, on the average better results in the matter of accuracy than the theoretical radius. The rule is based on the fact that 180 degrees $\div \pi = 57.3$ degrees, *i. e.*, a radian or an arc length equal to the radius. Hence, making the radius on a scale of one-tenth 57.3 makes each degree 0.1 inch in length.

SOME EXPERT OPINIONS ON TECHNICAL EDUCATION.

Some opinions on technical education, of interest, if not of value, were expressed at a meeting of a special commission on industrial and technical education held in Boston recently. One speaker referred to the well-known fact that there is a gap in technical education which is not filled by the public or technical schools. This gap is represented by the men so educated that they can fill the place between the industrial high-private and the industrial first-lieutenant. He said that we have done a great deal to develop captains of industry, but the places of non-commissioned officers, as it were, are lacking in competent men. He complimented the correspondence schools and said that they are doing a great work in this direction, there being something like 30,000 men taking instruction in this manner. From these remarks it may be inferred that men trained by a correspondence course, while not having the advantage of a technical training, surrounded by laboratory conveniences, will have an appreciation of the theory of their trades which better fits them for directing their work in the minor capacities.

Regarding trade schools, it was asserted that there is no

danger of flooding the ranks of industry, though some workingmen are afraid of it. Formerly, it is true, that employers did use schools for that purpose, but the situation is now entirely different. It is not true that a trade school will make it hard to maintain a standard of wages, but rather they help to maintain a high standard of efficiency and a corresponding standard of wages. It is also generally recognized that trade unions are doing good service in maintaining a standard of wages. The matter of trade education must be looked at broadly for the first purpose of the school is to benefit all the state, not any section or any class of citizens. Those who must earn a living should be shown how to do it. The Puritan idea is to think of abstract virtues and not of dollars and cents, but in real life both must be included. It is the poor, untrained men who are most likely to get into crime and distress. Make them happy and contented and crime decreases, and the way to do it is to make them productive, for true happiness lies in productive work.

AN ELECTRIC ACCELEROMETER.

Paper read by Mr. R. B. Owens before the November 2, 1904, meeting of the Canadian Society of Civil Engineers.

The advent of the electric motor as a competitor of the steam engine, especially in the traction field, has given rise to certain acceleration problems unfamiliar to engineers of a generation ago. At a time when the train mile was a satisfactory unit in which to reckon haulage costs, there was little occasion to bother with acceleration. Now, however, when neither the train mile, car mile, nor ton mile suffice, even when coupled with a speed factor as a basis of estimation and analysis, and when to maintain certain schedules more energy is expended in accelerating than in overcoming frictional and grade resistances, a simple, accurate, and reliable means of measuring acceleration is urgently demanded,—a means at least comparable in simplicity and accuracy to those employed in the measuring of the quantities of which it is the second

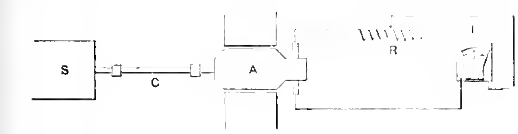


Fig. 1

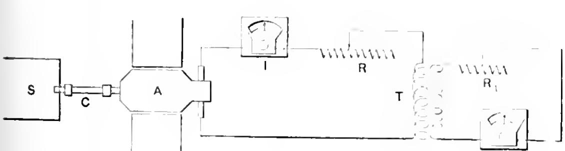


Fig. 2

and first differential with respect to time. Of practical methods of measuring velocity or speed, at least of machines, one of the most satisfactory, if not the most satisfactory, involves the use of a suitable constantly excited or permanent magnet dynamo mechanically driven by the part whose velocity is to be measured, and electrically connected through an ammeter to a circuit of constant coefficients as shown in Fig. 1. S is the shaft whose velocity is to be measured. C is a mechanical coupler. A is the armature of a small permanent magnet or constantly excited continuous current dynamo wound so as to have a negligible reaction within the limits of its use. R is a variable non-inductive resistance and I is a zero center d. c. ammeter. The reading of I will be proportional to the speed of S and, by adjusting R, can be calibrated in the revolutions per minute, feet per second, or miles per hour as desired. As the current through I is proportional to the speed, it is only necessary to determine the rate at which the current varies in order to have a measure of acceleration. This is simply and easily done by inserting in the circuit with I a transformer T with its secondary connected, for purposes of adjustment, through a non-inductive resistance R_1, to a zero center d. c. voltmeter V (see Fig. 2). The reading of the voltmeter V will then be proportional to the acceleration, positive or negative, of the shaft S.

Substituting recording instruments for the indicating ones shown, we have a recording speed indicator and a recording accelerometer. The transformer must have a straight line saturation curve and a large transformation ratio as the secondary induced voltage is necessarily small, and the voltmeter V must also be sensitive. The calibration of the ammeter as a speed indicator is effected by driving the armature A at different constant speeds as shown by ammeter reading, and taking the revolutions in a given time by means of a revolution counter and stop watch. The calibration of the voltmeter as an accelerometer is best done by driving the armature A by a separately and constantly excited motor having applied to its armature, preferably of small momentum, a voltage varying approximately as a linear function of time. With proper manipulation of apparatus the ammeter readings plotted against time will be a straight line whose slope will be constant and equal to acceleration and to the constant reading of the voltmeter to within a constant.

In some tests made in the writer's laboratory not long ago, A (see again Fig. 2) was the armature of a small low voltage separately excited d. c. generator; S the shaft of a 3 horsepower, separately excited d. c. motor to whose armature by a potentiometer arrangement a steady increasing or decreasing voltage could be applied; I and V Weston ammeter and milivoltmeter, and T a small lighting transformer with a transformation ratio of 20; and excellent results were obtained, speed and acceleration being read to exactly the same degree of accuracy that Weston d. c. ammeters and voltmeters are capable of. With recording instruments substituted, this would seem to meet every requirement of a practical apparatus for the measurement and recording of velocity and acceleration in railway work both steam and electric, and is applicable, of course, in many other connections.

MAKING TIGHT SCREWED JOINTS.

In an article in the December issue of the *Valve World* on the subject of making tight-screwed joints for very high pressure, Mr. R. S. Crane says that he is sure the trade generally does not understand the conditions that are necessary in order to make good work in this line. If the ordinary steam fitter were called upon to put up piping that should stand 200 or 300 pounds of steam pressure, he, no doubt, would feel that he was taking a very large responsibility. If he were called upon to do a job that should stand 1,000 pounds of air pressure he would not feel like taking this responsibility at all, and any one taking this responsibility would feel that he was obliged to resort to very extraordinary means in order to accomplish such a result; if called upon to do such work with the ordinary material that is manufactured and supplied in the general market, he would say that it was an impossibility to do it.

The Crane Company, however, had occasion some time ago to make joints tight in an 8-inch line so that they would stand 1,000 pounds of air pressure, and this was accomplished with the regular weight of line pipe and a coupling weighing about 24 pounds (which is the weight of a first-class line pipe coupling). The result of the experiment on thirty-two joints was that on the first test all were tight excepting one, and when this one joint was taken apart and again made up it also proved tight.

The secret of making such a joint is to overcome the friction in screwing the pipes together. Friction is due to the large amount of surface, especially when the joints are coming up close to a bearing. Any grit or gummy material in the joint also tends very largely to produce friction. Friction produces expansion, and as the pipe is lighter than the coupling it expands more than the coupling, and then when both again become cool the pipe shrinks more than the coupling, thus causing a tendency to leak. It is, of course, evident to any one who has given any thought whatever to this subject, that in order to make tight such joints as are mentioned above, the iron must be brought together as solidly as possible. To get such results it is imperatively necessary that the iron should be absolutely clean, and then it is essential that the very best lubricant is used in order to reduce the friction.

In order to produce good joints, it is not necessary that

the threads should be absolutely perfect, nor is a taper essential (one of the couplings in the experiment herein referred to had no taper at all, and others very little taper), nor is a large amount of bearing necessary; in fact, one joint was made with a thread reduced to ⅜ inch in width, and this joint was tight at 1,500 pounds hydraulic pressure, which proves that the bearing was not essential to the making of a tight joint, and that the length of thread was not essential to prevent stripping of the thread from the coupling or the pipe. This also proves another point that is not understood, and that is that it is not essential, in order do good work, to have especially long threads. In fact, it is believed that especially long threads are a detriment in making a good joint, for it stands to reason that such long threads tend to produce friction, which prevents the iron from coming up closely together, and the irregularity of the thread on the pipe tends to prevent the iron coming up in the closest contact. This will be better understood if we go to a great extreme in the matter. For instance, should it be undertaken to make a joint on 8-inch pipe, with a thread 6 inches long, the irregularities and friction would be so great that it would be impossible to get absolute thread contact.

THE REALIZATION OF IDEALS IN INDUSTRIAL ENGINEERING.

Extracts from a Paper read before the December Meeting of the A. S. M. E. by H. F. J. Porter.

Andrew Carnegie, when asked by a number of financiers whether he thought that the difference between one style of organization and another amounted to much, providing the company had an up-to-date plant properly located, said in effect that should some great catastrophe destroy all of his mills, but spare his organization, which had required many years to perfect, he might be inconvenienced temporarily, but that he could depend upon his organization to re-establish his business. If, however, he should lose his organization, even if his mills which were the best in existence were left intact, he would not have time nor strength to rehabilitate himself in the business world. Just as we have, for instance, recently seen it demonstrated that opposing armies and navies may have exactly the same guns, but that the side which has behind those guns the men of superior physique, character, intelligence and skill will win the battle, so also it has been proven that it is not the tool that determines either the quantity or quality of product, but the qualifications for efficiency possessed by the man behind the tool who controls and directs it.

What then are the qualifications with which a high grade organization should be endowed in order to attain a high standard of efficiency? Inasmuch as, after all, an organization is but a collection of human beings, it stands to reason that if as an entity it is to be of high grade the units of which it is composed must also be of high grade.

The attributes which human beings possess in common fall into three classes, *viz.*, physical, moral and mental, and in any manufacturing enterprise it is evident that the physical attributes are the most important. No matter how moral or intellectual a man may be, if he is a weakling, if he has not health, he cannot be an efficient part of an active organization.

Next he must be of high character, for no matter how healthy or intelligent a man may be, if he is immoral, *i. e.*, if he is dissipated, his condition physically and mentally while at work cannot be such as to qualify him as an efficient member of a high grade organization. His physical and mental powers are gradually affected, his sense of responsibility weakens, he becomes irregular in attendance, careless in attention to his duties and cannot be depended upon.

And finally, it is evident that, given a man of good physique and strong character, the higher his intelligence and skill in the direction of his duties the better qualified he will be to accomplish his daily tasks, but it is also evident from the preceding considerations that important as are these latter qualifications they must be subordinate to the other two and considered last in relative importance.

Now, I claim that the ordinary system of management in selecting and maintaining an organization, reverses the order in which the value of these qualifications for membership is estimated.

The questions usually asked an applicant for employment are:

First. Have you had a college education?

Second. What has been your practical experience?

Third. Have you ever been discharged? If so, what for?

Fourth. Give a list of people for whom you have worked.

Occasionally: Are you a drinking man?

But the self-estimate of what constitutes a drinking man makes the answer of little worth, and scarcely any interest is aroused by the amount of evasion displayed by the applicant.

Now, although we have seen that the human asset is of greater importance in an industrial enterprise than its mechanical possessions, I think I can safely say that infinitely more pains are taken in obtaining a machine or tool, to see that it is covered by detailed specifications and inspected during construction and before acceptance, than is given to securing the man who will be put in charge of it and held accountable for results from it afterwards. Experts from at least one department and frequently from several are consulted, and much time and thought are devoted to the consideration of the machine, but we rarely hear of a recognized labor or employment department in a shop, and when there is one it is seldom intelligently administered. Usually little care is taken in the selection of the men, and no thought is given to their improvement during their time of service. They are taken on and laid off without a thought of consideration for their welfare or convenience. No men can work at their best efficiency under these conditions.

Now there is one marked difference between machines and the men who operate them which should be noted here. Machines, no matter how well they may be cared for, depreciate from five to ten per cent per year owing to the advent of other and improved machines, while men, if they are properly cared for may appreciate in value several hundred per cent in the same time. Yet I maintain that as a general rule machines and tools are nurtured, fostered and preserved long after their period of usefulness has expired, while the permanency of service of the men of the organization who operate them receives comparatively no consideration whatever. It cannot be expected that the men of an organization will show any spontaneous enthusiasm for interest in or loyalty to a management that openly displays so little interest in their welfare.

A system of shop management which is suited to one industrial enterprise may work only indifferently in another and be a complete failure in a third. This statement may seem to be trite and unnecessary, but I know from my own experience that as long as men are constituted as they are, and they have probably not changed much since the time of Hamilton, whenever unusual conditions develop in a shop under any form of management, suggestions as to remedies which have been successful elsewhere are at once made by people who are well meaning, but have no knowledge of the actual situation.

What is needed, however, is a careful study by those whose knowledge of the conditions as they exist constitutes them as most competent to analyze the situation and deduce proper methods of procedure. In any manufacturing enterprise a standing committee on which both employees and management are represented and which meets at stated intervals is an excellent method of "getting together" those who are competent to act that each may see the other side of the shield and obtain the other's point of view.

There are frequent occasions arising when the management is anxious to know what attitude the employees would take in case a change in policy is made On the other hand, the employees from time to time wish to lay a request before the management. In either case some temporary device is usually resorted to to meet the occasion. When a standing committee exists, however, a channel of communication is always open and each side keeps thoroughly in touch with the other on all matters of common interest. An honor system is thereby established among the employees and the discipline improves greatly. I have never failed to see a marked change come over the entire organization as it rose to its responsibility as

soon as the members felt that they were accorded recognition as rational beings and were consulted on matters of common interest. Generally the rank and file of the working organization is considered in the same category as the privates in an army, they are not supposed to think, but to do as some one above them has planned. The usual result, as might be expected, is that they do not use their brains for the benefit of the concern.

All questions regarding systems of wage payments should come before the standing committee. The introduction of any of the various merit systems can be brought about in a shop with little difficulty if the subject is intelligently discussed by the committee in advance. In this country an appeal to reason is always accorded sympathetic reception, whereas the forcible application of a policy based on general assumption meets with merited resistance. And I should say here that as all men work primarily for their support the wage question is the one which must be settled first and satisfactorily before any schemes of industrial betterment can be effectively developed. Men work for wages, and will go where they can get the most pay. But of two concerns, each paying the same wage, the one which extends the better treatment to its employees will be favored by the applicants for employment and by judicious methods it can obtain the better class of help.

Some work of common interest must be developed to engage the attention of the standing committee and the sub-committees which later may be appointed to handle details. The Suggestion System now so generally adopted by the foremost concerns is a good subject for the committee to handle. This system develops in the operatives the power to observe, improves their capacity of initiative and inspires their ambition. It has besides the great advantage of being in itself a paying institution both to the employee and the company, when the latter pays well for valuable suggestions.

This system may include suggestions from the employees regarding improvements in their own conditions of comfort and work. No one knows better than the workman himself if he is not working under the most comfortable circumstances, but he will naturally hesitate to complain. Yet every one knows that a man when comfortable can do better work than when he is uncomfortable, and should be given an opportunity to express himself regarding his condition.

The system should also include suggestions regarding improvements in processes and methods of work. The operative, if encouraged to think, will soon effect great savings in the work at which he is more of an expert than any one else who is not constantly engaged at it. I have recently seen a product considerably redesigned, the process of manufacture simplified and made much cheaper and the company put upon its feet largely through the introduction of the Suggestion System.

Meetings of the foremen should be held regularly, and instruction should be given to them in the proper handling and management of men to secure the best efficiency within the limits of fair and just treatment. It must be understood that in order to secure the best quality of work the mind of the worker must be as free as possible from worry about his position. Peace of mind cannot be maintained while conditions exist which entail arbitrary discharge from service or unexpected reduction of wages, nagging by foremen who are affected by favoritism, ineffective facilities for service, unpleasant and unhealthful surroundings, danger of accidents from unguarded machinery, or loss of life in inflammable buildings inadequately supplied with means of escape. On the contrary, credit should be given to each employee for every effort to do his part in advancing the interests of the company. A little encouragement at the right time will do much to arouse ambition and enthusiasm, without which nothing of moment is accomplished.

I have already shown that health, character and intelligence in the order named are the essentials to be sought for in selecting an employee, and when found should be fostered and improved. First, then, efforts should be made to raise and maintain at a high grade the standard of health of the organization. Good health means capacity for work, both in efficiency when at work and through increased regularity of attendance. Irregularity in attendance is one of the banes of good management and it can only be improved by a careful investigation into its causes and application of the proper remedy. Mutual benefit associations are now quite general, but these where either a doctor or trained nurse is engaged to instruct the employees how to prevent sickness as well as to administer prompt and effective treatment during incapacity for work are effective means of increasing efficiency. Instruction how to live properly, how to cook simple food, how to eat, bathe and sleep, and warnings against the use of patented nostrums will tend to preserve the health of the organization and raise the regularity of attendance. The latter can also be effected by the payment of a bonus annually to those whose presence has met a certain percentage of regularity.

Some managers say that they are not interested in knowing what their employees do outside of working hours. Some employees say it is none of the manager's business what they do in their own time. When, however, what the employees do in their time affects what they do in their employer's time, then it may be to the latter's interest to look into such matters. What the employer should desire is to have as few changes take place in his organization as possible. Now, it should be remembered that in every factory there are apt to be many operatives who, because they are strangers in the locality or from reasons consequent to their condition and circumstances, have no opportunities for social recreation and pleasures and no places to go to after working hours. Therefore, being more or less creatures of circumstance, they drift into associations and habits which may be debasing in their tendencies. This sort of thing leads to a lowering of the status of the organization through association, if they remain in it, or to an unsettled state if there are many changes due to constant removals. The social instinct in man causes him to seek companionship and if opportunity is given the members of the organization to attend lectures and other social gatherings which are attractive and at the same time elevating in their tendency the whole fabric of the organization becomes homogeneous of high grade and remains intact. And, finally, the education of the employee should receive the attention it deserves. Early opportunity should be seized to improve the mind of the employee as he grows. The wider his knowledge, the better he will perform his duties.

Apprenticeship schools in operation during working hours under the charge of a trained teacher are effective means of developing the mentality of the organization and at the same time of getting in close touch with the employee early in his career, and the longer he stays with the concern and the more money is spent on his improvement the more valuable he becomes as an asset and the greater the effort should be made to retain him in the organization. Schools should be established in the factory during evenings for the purpose of helping the employee to advance in the organization. Energy, coupled with character and knowledge, guided by tact and discretion, will open the avenues of achievement. Care should be taken, however, not to coddle the organization. Coddling engenders weaklings. Extending opportunities so that the employees can help themselves develops self-reliance, self-respect, and, at the same time, regard for the management. Such a policy promotes a strong and healthy organization. Employees are quick to feel any interest taken in their welfare and as quick to reciprocate. To increase the efficiency of an organization so that each employee is not only a passenger in the enterprise, but effectively pulls his own weight, should be the object in view.

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It is the policy of the David Maydole Hammer Co. to replace any of their hammers which prove defective with proper usage. Some of their experiences with returned goods are amusing, as for example, the following: "Not long ago an old gentleman brought a nail hammer to the office. Said he was a carpenter, had just broken a piece from the face of his hammer, and asked if it was not defective. We knew by the shape that it was very old, which was verified by his admission that he had used the hammer continually for thirty years. We gave him a new one. Not because the old hammer had not done its work well, but for the old gentleman's 'cheek,' which was certainly 'well hardened.'"

N. Y. MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of the American Society of Mechanical Engineers, held in New York from December 5 to 8, was attended by over 700 members, and over 1,360 members and guests registered, making it not only the largest meeting of this society, but one of the largest that was ever held by any technical association. No attempt was made to use the society house on 31st Street, even for headquarters. Through the courtesy of the New York Edison Company, the handsome assembly and club rooms that they have fitted up for their employees in their new building at 44 West 27th Street were placed at the disposal of the society. The opening session was on the evening of the 5th, when retiring President John R. Freeman, of Providence, R. I., delivered the annual address. Mr. Freeman is one of the leading authorities of the country on fire protection and spoke mainly upon the fire protection of theaters. He gave an interesting résumé of the experiments and investigations which followed the Iroquois disaster in Chicago and the conclusions to which those investigations led, pointing out the utter inadequacy of the usual facilities for preventing the spread of fire in the modern playhouse. He criticised severely the asbestos curtain as now required in theaters because of its certainty to crumble at high temperatures, as has been proven by laboratory tests. The interesting statement was also made that various liquids and powders used in hand grenades and similar apparatus which had been purchased in different cities were found to be valueless, or at least not particularly better than water, or sand—the grenades contained a brine of salt and water and the powder was chiefly bicarbonate of soda or baking soda.

It is becoming more and more the custom to introduce social features of unusual interest at these meetings, and it is a question whether these are not fully as great a drawing card as the technical papers and discussions. Perhaps they are of even greater value to the members because of the opportunity afforded for interchange of ideas, particularly in view of the fact that the papers, with the discussions, are afterward distributed in book form. At any rate, the unusual attractions arranged for by the committee met with the hearty approval of those in attendance at these sessions.

On Wednesday morning the society enjoyed the novelty of a session on board the *Amerika*, the largest vessel afloat, then at her dock at Hoboken, following which was a trip to the immense new works of the Worthington Hydraulic Works at Harrison, N. J. This is the largest plant in the world devoted to the manufacture of hydraulic machinery and is the outgrowth of the original hydraulic works at Brooklyn, N. Y. The new buildings have an area of about forty acres, the largest of which is the machine shop, 1,000 feet long. The visitors were taken to the plant in a twelve-car train and luncheon was served at the works, but the crowd was so great that the facilities provided were barely sufficient to accommodate those in attendance. Between 800 and 900 people availed themselves of the opportunity to visit this interesting plant.

Another part of the entertainment that was somewhat out of the ordinary and enjoyed by all was the lecture on Wednesday evening by Prof. R. W. Wood, of Johns Hopkins University, who took as a subject the "Photography of Invisible Phenomena." He threw on the screen photographs of many subjects not observable with the naked eye, that greatly interested the spectators. One of the most notable series of illustrations was photography of the sound waves produced by the explosion of a can of dynamite; and so marked were these waves that the shadow caused by them was discernible in the photographs taken by a kinetescopic camera. The illustrations that captured the audience were what Prof. Wood called his "fish-eye" views. If he is correct in his surmises, a fish looking upward to the surface of a quiet pool of water has a range of vision limited only by the horizon; due to the fact that rays of light coming to the surface from points at the horizon are refracted and so reach the eye of the fish. Acting on this supposition, the Professor placed a photographic plate in the bottom of a pail filled with water and in which was a diaphragm supporting a lens. This simple apparatus placed out in the street or a public square produced a negative covering a range of vision of 180 degrees, or in other words from horizon to horizon, and was in the form of a circle with the trees, houses, etc., pointing radially inward.

At the business meeting on the steamship *Amerika* occurred the annual election of officers, Fred W. Taylor being elected president for the ensuing year and Walter McFarland vice-president. Mr. C. W. Hunt reported the progress upon the Engineering Building and announced that the December, 1906, meeting would probably be held in that building. The present house of the society is rated as worth $125,000 and an offer of $115,000 has already been made for it, which places the

The New Engineering Building.

society in good financial condition. The total membership was stated as about 3,000. One of the pleasant events was the election of Charles H. Haswell, the first chief engineer of the United States Navy and the oldest engineer in America, to honor any membership of the society.

A report was presented by the society's committees on standards for machine screws, by George M. Bond, which drew out considerable discussion, much of which was unfavorable. It was contended that many of the sizes chosen did not correspond with wire gage sizes and Mr. Burlingame, of the Brown & Sharpe Manufacturing Co., suggested that rounded corners be adopted for filister-head screws, instead of the oval form, as it is not necessary to be so careful in counterboring any exact depth in order to have the screws look right. There was also some discussion of the methods of measurement of screw threads, in which considerable diversity of opinion was expressed.

The list of subjects of the technical papers given at the several sessions is as follows: Report of Committee on Standard Proportions for Machine Screws; "Use of Natural Gas Under Boilers," by Jay M. Whitham; "Reinforced Concrete Applied to Modern Shop Construction," by E. N. Hunting; "Measurement of Air Flowing Through Circular Orifices in Thin Plates," by R. J. Durley; "Results of Preliminary Producer Gas Tests, U. S. Geological Survey Testing Plant, St. Louis, Mo.," by R. H. Fernald; Pressure Drop Through Poppet Valves," by Charles E. Lucke; "Test of Elevator Plant, Trinity

Building, New York City," by A. J. Herschmann; "The Realization of Ideals in Industrial Engineering," by H. F. J. Porter.

The paper upon the elevators of the Trinity Building stirred up a small hornet's nest, making it evident that there is more or less opposition to the plunger elevator for high-speed passenger work. The paper by H. F. J. Porter dealt with industrial betterment, and he threw many photographs on the screen showing the work done along these lines and the improved conditions resulting, in many sections of the country.

It has been the custom for many years to have topical discussions at the meetings upon subjects that designers and engineers need practical data upon. The subject for this meeting was "Bearings," and a great deal of material was contributed which, when taken together, will make by far the best treatise on the subject of bearings that has appeared anywhere. Many drawings of ball and roller bearings were shown and data was presented in regard to pressure, durability, metals, lubrication, etc. The discussion of this subject took up nearly the whole of one session, which was prolonged over an hour to give as many as possible an opportunity to speak.

Abstracts of the more interesting or valuable papers will be given in the *Engineering Review* of this and succeeding months.

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THE ENGINEERING BUILDING.

A report has been issued by the joint committee representing the Electrical, Mechanical and Mining Engineering Societies in the committee of the Engineering Building. The erection of this building, which is the gift of Andrew Carnegie, is now well under way, at 39th Street, New York. The frame work has reached the fourth story and it is expected that the building will be ready for occupancy next October. The following particulars in regard to the building, taken from the report, are of general interest. The building is to serve the convenience of the three societies, each of which will have one floor for its business offices, committee rooms, etc.

It is expected that the Engineering Building will eventually become the engineering headquarters of America, not only making a home for the three societies mentioned, but affording opportunities for meetings of many other technical societies and providing office room for their headquarters. A sufficient number of offices, therefore, are included in the plans for the accommodation of such societies, and there are to be meeting rooms and auditorium rooms of various capacities adapted to the needs of the different organizations.

The largest of these, designed primarily for the conventions of the three national societies, will accommodate 1,000 persons, this limit being set as the largest number that can be expected to hear clearly the voice of a speaker. The location of this auditorium is on the first floor above the ground, so as to make elevator service unnecessary. On the floor above are two assembly rooms occupying the principal portion of the area, one seating 450 and the other 300. These may be used independently for lecture purposes or one may be made auxiliary to the other and used as a foyer or conversation room; or they may be used in common for social or reception purposes. There are also smaller rooms on the floor, including a kitchen and serving room for light refreshments or luncheon.

On the next floor above are four small lecture halls suitable for ordinary meetings of scientific and engineering societies, seating from 100 to 250 each.

The meeting rooms of all sizes will be fitted for the use of the stereopticon and will be supplied with electric current, compressed air, gas and water, making them complete in every respect for lectures requiring experiments or demonstrations. A freight elevator will serve the building, connecting not only with the office floors so that pamphlets may be received or shipped, but with the floors containing the lecture rooms, so that apparatus and machinery may be delivered in any of these rooms to illustrate a lecture, if desired.

The crowning feature of the building is the provision for the libraries on the upper floors. There will be one common reading room on the top floor with alcoves for the libraries of the individual societies, and the floor below is to be reserved for book stacks with sufficient capacity to accommodate the growth for many years to come. It is the purpose of the societies so to administer the library of each that by bringing them together there shall be a working and reference library of the highest possible value and completeness as respects engineering science and practice. It is believed that by the co-operation of the New York public library on the adjoining block the library in the Engineering Building can be made the most important engineering library of the country and will become the center to which engineers will go for technical information.

The property on which the building is located has 125 feet front and is 100 feet deep. The building laws require that not more than 85 per cent of the lot area shall be occupied and there has accordingly been left a space on all sides of the building, giving it a monumental appearance, and all the rooms will be well lighted. The illustration accompanying this description is from a photograph of the architect's drawing and shows a handsome and impressive structure.

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FREDERICK W. TAYLOR.

New President of the A. S. M. E.

The newly elected president of the American Society of Mechanical Engineers, Frederick W. Taylor, was born in Germantown, Pa., in 1856. He was prepared at the age of eighteen to take a course in Harvard College, having taken a preparatory course in Phillips-Exeter Academy, but at this time

Frederick W. Taylor.

his eyes gave out and he had to give up study, which perhaps was fortunate for the world at large, for it caused him to get an education in another way, bringing him directly in contact with industrial conditions. He served an apprenticeship as a patternmaker in a small steam pump works in Philadelphia, and in order to make rapid progress and get special advantages he worked for less pay than the other apprentices, and in four years finished his apprenticeship both as a patternmaker and a machinist. When he had finished his apprenticeship, in 1878, times were so dull that he could not get work at his trade so he went to work in the machine shop of the Midvale Steel Co. as a laborer. Here he was rapidly promoted, being successively shop clerk, tool room foreman, gang boss, assistant foreman and general foreman of the machine shop. Next he became master mechanic in charge of repairs and maintenance of works; then chief draftsman, and in 1884 chief engineer of the works. Thus, in the short period of six years he worked up from laborer to chief engineer. But with all his work with the Midvale Steel Co. he found time for home study. Soon after he went there he felt the need for a more complete engineering education, and in 1880 began study at night in the engineering course of Stevens Institute in addition to his work of ten hours per day. He passed all his examinations and graduated with a degree of mechanical engineer in 1883. The sobriquet "Speedy Taylor," which he

afterward earned with the Bethlehem Steel Co., seems to have been well merited in his early career.

Leaving the employ of the Midvale Steel Co. in 1890, he organized and managed some pulp mills, and after accomplishing this work he has since devoted his entire time to the organizing of various manufacturing establishments. Mr. Taylor's most important engineering work consists of the design of a great part of the plant and machinery of the Midvale Steel Co., including the largest steam hammer running in this country. This hammer has been working steadily and with very little repair since 1890. For twelve years it made all of the large gun forgings sold by the Midvale Steel Co. to the United States government, competing during this time, successfully, with the large and expensive forging presses used by the Bethlehem Company. This hammer was built on an entirely new and original design made and patented by Mr. Taylor, and in this connection it may be mentioned that he has taken out something over fifty patents. His name, however, in the engineering world is chiefly identified with his system of shop management and the Taylor-White process of treating tool steel, which, perhaps, has worked the greatest revolution in machine shop production of any discovery of recent times. In shop management he endeavored to reduce it to an art and his system is now used successfully in many establishments covering a large variety of work, the principal concerns being the Midvale and Bethlehem steel companies. It was in connection with the latter that he and Mr. Maunsel White developed the Taylor-White process of heat treatment for air-hardening steels by which they were made capable of standing cutting speeds much higher than had heretofore been possible.

He has presented several important papers before the A. S. M. E., among which are the following: "A Comparison of Various Fuel Gases," "Notes on Belting" (describing a practical experiment on the treatment and durability of all belts in a machine shop extending through a period of nine years), "A Piece Rate System," and "Shop Management." He also published this year, together with Mr. Sanford E. Thompson, a book of five hundred pages on "Concrete, Plain and Reinforced."

That Mr. Taylor is not wholly wrapped up in his engineering work is indicated by the fact that he won the first double championship at Newport and this he considers his most important (*sic*) achievement.

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THE SHIFTING OF THE COTTON INDUSTRY FROM NORTH TO SOUTH.

The early mechanical history of New England and the work of her early mechanics is largely concerned with the development of the cotton industry. The manufacture of cotton goods has been the foundation of much of the industrial success of this section, and the gradual shifting of the center of the industry from the New England States to the cotton states of the South, where, it must be admitted, it rightly belongs, will be a serious blow to the pioneer States in this line of manufacture.

The latest move toward the grounding of the industry in the South is an important water power development on the Yadkin River, near the town of Whitney, North Carolina. There is here available a fall of 129 feet and a volume of water sufficient to develop 54,000 horse power. Six water turbines are to be installed, direct-connected to alternating-current generators of 5,000 kw. capacity. The generators will operate at 11,000 volts, a pressure that will carry a current a distance of 12 miles, with a loss of only 2 to 4 per cent. For greater distances there will be transformers to step the voltage to 30,000 and to 60,000 volts, the latter for transmission to points at a distance of 80 to 100 miles. Within 80 miles of the plant there are now said to be 278 cotton mills, all of which, from the smallest to the largest, can use this power and each of which can thus derive the benefit of the economical production of power on a large scale, such as could be realized only with steam plants of immense size, were steam to be used for power.

It is estimated by the engineers that when the whole 54,000 horse power is taken up, additional power can be developed by other installations above and below the present one on the same river.

The question of power is a serious one for New England industries. While the water power furnished by her swift-running streams has been the means of the establishment of many factories, this power must usually be developed on a small scale, compared with the immense plants that are now coming into use on some of the larger rivers in other sections, in connection with electrical transmission. Small plants mean a large investment for the power developed, and this fact, together with the necessity for steam heat in our northern climate during eight months of the year, has led many engineers to question whether, after all, it was not cheaper to use steam for power during the whole twelve months.

Another reason why New England is at a disadvantage with the South is because of the wage condition. When Samuel Slater started his first water spinning mill at Pawtucket, R. I., in 1790, there began the dawn of a new era in industrial conditions. It meant the shifting of an important industry from the home to the factory. The spinning and weaving in the home were done by women, and they followed the industry to the factory and have since formed a considerable portion of the help employed in cotton factories. It is a law of economics that the money earned by the average family bears a fixed relation to the value of the commodities consumed by the same unit, and this holds whether several members of the family are employed, or the head of the family only is at work. That is, in industries where only men are employed, the wages per family amount to practically the same as in industries of a similar grade where several members of the family are earners. The consequence is that the prevailing rate of wages in the cotton industry has been low and there is bound to be more or less pressure brought to bear by the employers to secure wage rates commensurate with those in other lines of industry. In the South, however, where the prevailing rates are lower, as a whole, this trouble is not likely to be encountered to so great an extent.

In the face of these conditions the Southern mills have started and some of them are now preparing to take advantage of one of the large water powers from which power can be transmitted electrically and utilized at less than the cost for steam power, which, with the cheap Tennessee coal, is much less than in the North. It would seem that the new plant at the Yadkin River will, if successfully completed, constitute an important step in the development of the mechanical history of the South; and possibly in the undoing of history in the North.

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The American Woolen Co. is building at Lawrence, Mass., what will be the largest worsted mill in the world, to eventually employ 5,000 hands. A novel feature of the plant will be the installation of an escalator, or traveling staircase, for carrying employees to and from the various floors. The escalators are to be installed in a special building situated between the wings of the factory proper. Two of these will run in parallel from the second to the fourth floors, it being contemplated that the employees will either walk down from the fourth to the third or ascend by ordinary stairs from the second to the third floor. One escalator will run from the fourth to the fifth floor and one from the fourth to the sixth. It is believed by the management of the American Woolen Co. that this installation will not only add to the comfort and convenience of the employees, a large proportion of whom are women, by making it unnecessary for them to go up or down long flights of stairs, especially when tired out by a day's work, but that it will also increase their efficiency to a considerable extent. The escalators will run in a downward direction at the beginning of the noon hour and at the closing of the mill at night, and also in the event of fire. At other times they will run in an upward direction. This type of traveling staircase is built by the Otis Elevator Co., New York City, and the fact that it is reversible and will run in either direction apparently makes it unusually well adapted to factory use. It is estimated that if elevators were installed it would require one hundred of them of ordinary size to carry the same number of employees to the different floors within the same length of time that the escalator will carry them.

THE CONRADSON SPEED BOX.

A variable speed device has recently been patented by C. M. Conradson, mechanical engineer, New York, and is now being developed as a speed box for driving engine lathes. The device combines a number of features that are of unusual interest because of their novelty. The speed changes are obtained in steps by means of different combinations of gearing, but unlike other gear devices the changes may be made rapidly, while power is being transmitted, without the shock or danger of breakage incident to speed boxes having clutches or slip gears of the usual type.

The mechanism of the Conradson speed box consists of one or more sets of gearing, each of which has a clutch of peculiar design, all of the sets being duplicates of one another. These units, consisting of the clutch and the train of gears, are inclosed within a cylindrical casing and are placed in a row, one following the other and concentric with the same axis. The illustration, Fig. 1, shows a speed box having two units, which will give four changes of speed. Power is transmitted from the receiving pulley at the left to the pinion at the extreme right which delivers power to the lathe or other machine that is to be driven. There are three separate shafts, *A*, *B*, and *C*, all having the same axis. The first shaft connects the driving pulley with the first train of gears; the second connects the two trains of gears; and the third, the last train with the pinion at the right. When all the gears are locked they become inoperative so far as changing the conical friction surfaces; second, clutch teeth which are beveled or cam shaped so that when they are in mesh there will be a tendency for these cam surfaces to crowd two parts of the clutch apart. The third element is a split ring having beveled surfaces which bear against corresponding surfaces of the clutch and draw the same two parts of the clutch together.

In Fig. 1 *G* is a conical disk fast to shaft *A*, and *F* is a ring free to slide in an endwise direction, having beveled surfaces as indicated. These constitute the first element or the friction part of the clutch. At *f* are the bevel clutch teeth which mesh with corresponding teeth on the face of carrier *D*. The ring *F* is forced to the left against the conical surface of *G* by means of the spiral spring shown which acts as a "teaser." That is, suppose the conical disk *G* to rotate and the ring *F* to be forced against the conical surface of the disk by means of the spring. The ring *F* will evidently tend to turn with the shaft *A* and its disk *G*, but the carrier *D* will tend to lag behind, inasmuch as it is connected, through the gearing, with the driven part of the mechanism. The second element, which consists of the clutch teeth *f*, therefore goes into action and forces the ring *F* against the friction surface of *G*, with the result that it turns with *G* and, because of the clutch teeth *f*, carries with it also the carrier *D* and its gearing and thus compels shaft *B* to rotate with shaft *A*. In other words *A* and *B* are locked together and the greater the power transmitted the more positively will the elements be locked because of the crowding action of the clutch teeth *f*.

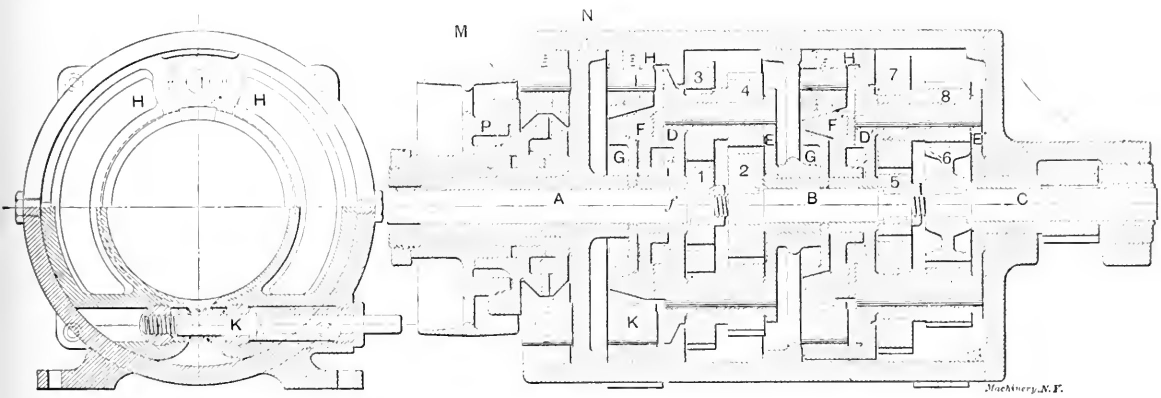


Fig. 1. Longitudinal Section through Conradson Speed Box of Two Units.

speed is concerned, and the three lengths of shafting, *A*, *B*, and *C*, rotate as one piece, the pinion at the right making the same number of turns per minute as the pulley at the left. With the first train of gears in operation and the second train of gears locked, a second speed is obtained; with the second train in operation and the first locked a third speed, and with both trains in operation a fourth speed is obtained.

On the right end of shaft *A* is keyed pinion 1, which, when permitted to do so, drives through the back gears 3 and 4, (as well as through back gears located oppositely at the bottom of the drawing, but which for simplicity will not be referred to), to the pinion 2 keyed to the left end of the shaft *B*. The back gears 3 and 4 rotate as one piece upon a pin carried by disks *D* and *E*, which turn loosely upon shafts *A* and *B* respectively. When these disks are prevented from rotating it will be evident that the back gears will operate to reduce the speed of shaft *B* after the usual manner of back gearing. On the other hand if these disks are made to rotate with shaft *A* the only effect will be to lock shaft *B* with shaft *A*, and so produce no change in velocity ratio. This control of the action of disks *E* and *D* is accomplished by means of a clutch of peculiar and interesting construction, which acts exactly the opposite from the ordinary clutch. That is, when the operator makes a movement corresponding to that of "throwing in" the ordinary clutch, he throws this clutch out of action; and it is thrown into action when he makes a movement corresponding to the release of the ordinary clutch, this throwing in being accomplished by the positive action of the mechanism itself.

The clutch consists of three essential elements: First,

Now, if it is desired to throw out this clutch and allow shaft *A* to drive shaft *B* through the back gears, thus reducing its speed, the third element, *H*, is brought into play, which consists of two segments of a ring pivoted at *I* and drawn together at the bottom by the screw *K* which is under control of the operator. These segments of the ring are fixed to the casing and have beveled surfaces which bear against the bevel on the outside of ring *F*, and on the periphery of carrier *D*. By drawing the two segments together at the bottom, the sliding ring *F* and the carrier *D* are crowded together (as shown in a second mechanism at the right), thus releasing the friction surfaces of *G* and *F*. Referring now to the mechanism at the right, which is drawn with the several parts in the positions they would assume under the above conditions, we see that, while the ring *F'* does not bear against *G'*, it does bear against the corresponding conical surfaces of the segments, which thus form a brake tending to prevent the rotation of ring *F'*. In this case, however, the carrier *D'* tends to continue in motion, owing to the power that is being transmitted through the train of gears, and the clutch teeth act to force ring *F'* solidly against the friction surface of the segments *H'*. The result is that the carrier *D'*, and with it, of course, *E'*, are locked so that they cannot move and power then is transmitted through gears 5, 7, 8 and 6 to the shaft *C*.

It will be noted that in each case the tendency of the cam teeth of the clutch is to crowd the sliding ring to the left, but in one instance it forces it against the rotating piece so that it must travel with it, causing the train of mechanism to revolve about the common axis; while in the second case it is forced just as positively against the stationary surface of the

brake, which prevents the train of mechanism from revolving about the axis. Another important feature is that all the gears are running only at the lowest speed of the last or driven element; part of the gears at intermediate speeds; and none of them at the highest speed, when the speed is 1 to 1.

The driving pulley P transmits power to the shaft A through a clutch similar in operation to the clutches just described.

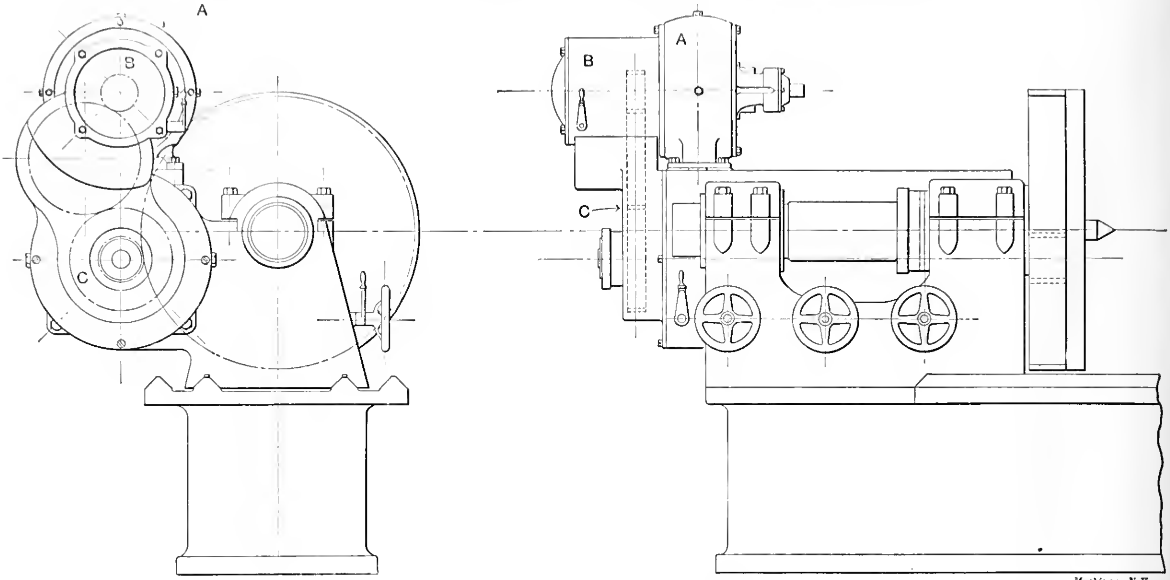


Fig. 2. The Conradson Drive applied to a Lathe.

The sliding element M comes in contact with the bevel surface P of the pulley and the element N is keyed to the shaft A. There are clutch teeth between the pieces M and N. The segments of the ring which form the brake draw the elements M and N together, releasing the clutch just as in the previous case. When, however, the segments of the ring are separated, the clutch is thrown in contact with the conical surface of the pulley by the resistances of the mechanism.

Fig. 2 shows an arrangement of the device for driving an engine lathe by means of a constant speed motor. The main speed box is located back of the spindle and drives the latter by a gear on the face place. This illustration shows a three-unit speed box, each unit being controlled by a hand wheel at the front of the head stock. There are thus eight combinations possible, giving eight changes of speed with this one speed box. There is also a one-unit speed box attached directly to the motor frame at B, giving two speed changes, which, taken in connection with those of the main speed box, provides sixteen changes of speed. The brake ring of the motor speed box is operated by the lever shown at the left-hand end and there is a clutch operated by a similar lever at the left end of the main speed box. The hand wheels have been adopted for controlling the speeds in machine tool work, and are probably as convenient for this purpose as any arrangement. In automobile work, however, it will be desirable and quite possible to arrange either a sliding or a rotating cam that would throw in the successive units in their proper order by the movement of a single lever or one hand wheel. This means if a car were running at say 40 miles per hour and it was desired to slow down, the change could be brought about instantly by shifting the position of the speed through the successive steps.

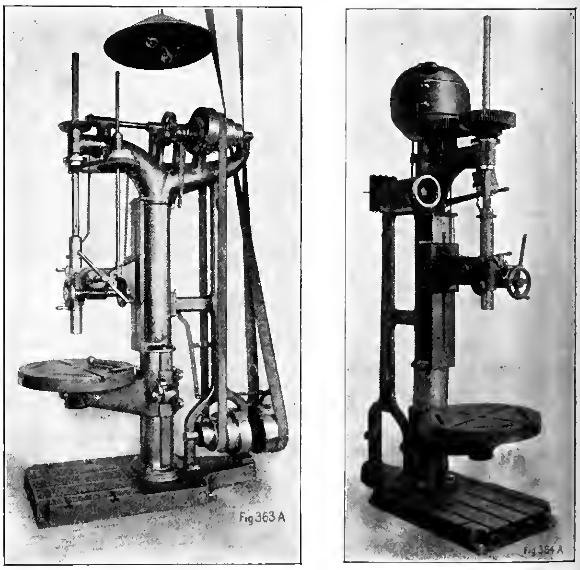
The Conradson speed box is being developed and placed on the market by the Industrial Engineering Co. of America, New York City, and a lathe is now under construction to which the speed box is to be attached.

* * *

A trackman on the Manhattan Elevated railroad recently dropped a track wrench across the third-rail and a track rail thus forming a short circuit which badly burned the unfortunate laborer, fused out a section of the track and blocked traffic for half an hour. If the damage to the men and delays to traffic because of this foolish construction could be accurately computed we suspect that it would figure out several times the alleged great cost of protecting the third-rail of this installation but cent-wise-and-dollar-foolish methods are responsible for some queer engineering.

THE SIMPLICITY OF THE ELECTRIC DRIVE.

The two cuts below show a 30-inch drill press as it was before and after being changed to a motor drive. The drill was formerly belt driven by the usual loose pulley and cone pulleys mounted in the frame of the machine at the rear, the upper cone pulley driving the vertical spindle through bevel gears. These shafts, cone pulleys, belts, and bevel gears, were



Before and After the Application of a Motor Drive.

all removed and a Crocker-Wheeler, vertical type, motor substituted, the result being a considerable loss in complexity of mechanism, and a corresponding gain in ease of handling and general appearance. The variations in speed are obtained solely through the motor, which is supplied with current from a four-wire multiple voltage system. The spindle speeds range from 51 to 276 revolutions per minute.

HAND REAMERS.

H. D.

Hand reamers probably are amongst the most difficult and particular tools to make and manufacture. I have seen and tried many hand reamers manufactured by firms considered to be leading in the making of small tools. However, no regard or attention seems to have been given to some of the most essential points in the making of these tools. As, of course, everybody knows, it is absolutely necessary when making a *good* hand reamer to take into consideration that the reamer is expected to produce: 1. a smooth hole; 2. a straight hole; and 3. a round hole.

If we now first consider what means are generally used for making reamers that will produce a smooth hole, we will find that three ways have been tried with more or less success. The first and earliest means used to prevent chattering were to make an odd number of flutes in the reamers but this has been almost entirely discarded on account of the difficulty in measuring the diameter of such reamers. At present some manufacturers, in order to overcome the vibrations which spoil the smoothness of the hole, make their reamers with spiral flutes. This, although partly overcoming the difficulty referred to, has several serious disadvantages. In the first place such a reamer is more difficult and more expensive to flute, not to mention the difficulty of giving such a reamer the proper relief. In the second place a reamer fluted in such a way has the disadvantage of either working forward or resisting, depending on whether right-hand or left-hand spiral flutes have been given to the reamer in question. It may be noted that it is preferable to make right-hand reamers of this description with left-hand spiral flutes and *vice versa*, which will prevent the reamer from working forward. Someone might think that the working forward of the reamer (to a certain extent depending upon the amount of spiral given to the flutes) would rather be an advantage, and so it would, provided that the forward motion could be on the one hand perfectly uniform, and on the other hand small enough to advance the reamer a very limited distance for each revolution. This result, however, can be obtained in a very much simpler and cheaper way by using straight flutes and threading the reamer on the point for a short distance. The advance of the reamer in this case will of course be governed by the pitch of the thread. The outside diameter of the threaded portion must obviously be slightly smaller than the diameter of the reamer itself.

Returning to our original consideration in regard to the means employed to prevent vibration, the third way used is to "break up the flutes," which means that the cutting edges are not equally spaced, although the reamer then is given an even number of flutes. This ununiformity in spacing need not be greater than to permit a gaging of the diameter of the reamer over two opposite cutting edges that will be correct for all practical purposes. The "breaking up of the flutes" is the simplest and most effective way to obtain the result wanted, viz., a smooth hole. Leading manufacturers are commencing more and more to manufacture their reamers in this manner.

The second consideration which was mentioned above as necessary for a good reamer was its capability of producing a straight hole. This is the principal point to which I referred in the beginning of my article which seems to have been wholly disregarded by manufacturers of reamers. No reamer will produce a straight hole unless it is properly started, and no reamer will start properly unless it is properly guided. It is obvious that even with the most extreme care, and handled by the most experienced man, a reamer without a guide will make the hole slightly tapered, and too large at the end where the reamer first enters the work.

The way hand reamers are generally made for the market is to simply taper the point for a certain distance up, leaving nothing to steady or guide whatsoever. This is not right. Instead a fluted cylindrical portion of the end of the reamer should be left without relief, and this part should be so much less in diameter than the reamer itself as is practical for various metals to be cut with the reamer. As this amount is very small, and is left entirely to the judgment of the manufacturer, the practice of making reamers with guides slightly smaller than the diameter of the reamer would prevent the user from misusing and abusing the tool as he cannot use it to remove a greater amount of metal than the reamer is intended for, because the guide will not enter a hole that is not roughed out sufficiently large before hand reaming. When using a reamer with a tapered point it is usually possible to enter and start the reamer in holes so much smaller than the finished size as to seriously injure and even spoil it, by trying to make it perform a duty for which it was not intended, this being possible because the taper is by most manufacturers made so large as to permit such a thing.

The third consideration referred to above, and essential to a good reamer, with its capability of producing a round hole. Most of the reasons set forth in the first part of the article treating the possibilities of getting a smooth and a straight hole reappear here, and it may well be repeated that unevenly

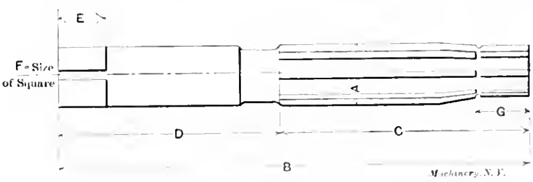


Fig. 1.

TABLE I. PROPORTIONS OF HAND REAMERS.

Diam.	Total Length.	Length of Flute.	Length of Shank.	Length of Squared Part.	Size of Square.	Length of Guide.
A	B	C	D	E	F	G
1/16	2 3/16	7/8	1 5/16	7/32	3/64	3/16
1/8	2 5/8	1 1/8	1 1/2	1/4	3/32	7/32
3/16	3 1/16	1 3/8	1 11/16	9/32	9/64	1/4
1/4	3 1/2	1 5/8	1 7/8	5/16	3/16	5/16
5/16	3 15/16	1 7/8	2 1/16	11/32	15/64	3/8
3/8	4 3/8	2 1/8	2 1/4	3/8	9/32	13/32
7/16	4 13/16	2 3/8	2 7/16	13/32	21/64	7/16
1/2	5 1/4	2 5/8	2 5/8	7/16	3/8	1/2
9/16	5 11/16	2 7/8	2 13/16	15/32	27/64	9/16
5/8	6 1/8	3 1/8	3	1/2	15/32	19/32
11/16	6 9/16	3 3/8	3 3/16	17/32	33/64	5/8
3/4	7	3 5/8	3 3/8	9/16	9/16	11/16
13/16	7 7/16	3 7/8	3 9/16	19/32	39/64	3/4
7/8	7 7/8	4 1/8	3 3/4	5/8	21/32	25/32
15/16	8 5/16	4 3/8	3 15/16	21/32	45/64	13/16
1	8 3/4	4 5/8	4 1/8	11/16	3/4	7/8
1 1/16	9 3/16	4 7/8	4 5/16	23/32	51/64	29/32
1 1/8	9 3/8	4 15/16	4 7/16	3/4	27/32	15/16
1 3/16	9 9/16	5 1/16	4 1/2	25/32	57/64	31/32
1 1/4	9 3/4	5 3/16	4 9/16	13/16	15/16	1
1 5/16	9 15/16	5 5/16	4 5/8	27/32	63/64	1 1/32
1 3/8	10 1/8	5 3/8	4 3/4	7/8	1 1/32	1 1/16
1 7/16	10 5/16	5 1/2	4 13/16	29/32	1 5/64	1 3/32
1 1/2	10 1/2	5 5/8	4 7/8	15/16	1 1/8	1 1/8
1 9/16	10 11/16	5 3/4	4 15/16	31/32	1 11/64	1 5/32
1 5/8	10 7/8	5 13/16	5 1/16	1	1 7/32	1 3/16
1 11/16	11 1/16	5 15/16	5 1/8	1 1/32	1 17/64	1 7/32
1 3/4	11 1/4	6 1/16	5 3/16	1 1/16	1 5/16	1 1/4
1 13/16	11 7/16	6 3/16	5 1/4	1 3/32	1 23/64	1 9/32
1 7/8	11 5/8	6 1/4	5 3/8	1 1/8	1 13/32	1 5/16
1 15/16	11 13/16	6 3/8	5 7/16	1 5/32	1 29/64	1 11/32
2	12	6 1/2	5 1/2	1 3/16	1 1/2	1 3/8
2 1/16	12 3/16	6 5/8	5 9/16	1 7/32	1 35/64	1 13/32
2 1/8	12 3/8	6 11/16	5 11/16	1 1/4	1 19/32	1 7/16
2 3/16	12 9/16	6 13/16	5 3/4	1 9/32	1 41/64	1 15/32
2 1/4	12 3/4	6 15/16	5 13/16	1 5/16	1 11/16	1 1/2
2 5/16	12 15/16	7 1/16	5 7/8	1 11/32	1 47/64	1 17/32
2 3/8	13 1/8	7 1/8	6	1 3/8	1 25/32	1 9/16
2 7/16	13 5/16	7 1/4	6 1/16	1 13/32	1 53/64	1 19/32
2 1/2	13 1/2	7 3/8	6 1/8	1 7/16	1 7/8	1 5/8
2 9/16	13 11/16	7 1/2	6 3/16	1 15/32	1 59/64	1 21/32
2 5/8	13 7/8	7 9/16	6 5/16	1 1/2	1 31/32	1 11/16
2 11/16	14 1/16	7 11/16	6 3/8	1 17/32	2 1/64	1 23/32
2 3/4	14 1/4	7 13/16	6 7/16	1 9/16	2 1/16	1 3/4
2 13/16	14 7/16	7 15/16	6 1/2	1 19/32	2 7/64	1 25/32
2 7/8	14 5/8	8	6 5/8	1 5/8	2 5/32	1 13/16
2 15/16	14 13/16	8 1/8	6 11/16	1 21/32	2 13/64	1 27/32
3	15	8 1/4	6 3/4	1 11/16	2 1/4	1 7/8
3 1/8	15 3/8	8 7/16	6 15/16	1 3/4	2 11/32	1 15/16
3 1/4	15 3/4	8 11/16	7 1/16	1 13/16	2 7/16	2
3 3/8	16 1/8	8 7/8	7 1/4	1 7/8	2 17/32	2 1/16
3 1/2	16 1/2	9 1/8	7 3/8	1 15/16	2 5/8	2 1/8
3 5/8	16 7/8	9 5/16	7 9/16	2	2 23/32	2 3/16
3 3/4	17 1/4	9 9/16	7 11/16	2 1/16	2 13/16	2 1/4
3 7/8	17 5/8	9 3/4	7 7/8	2 1/8	2 29/32	2 5/16
4	18	10	8	2 3/16	3	2 3/8

spaced (broken up) cutting-edges, and a guide, nicely fitting in the hole to be reamed, are the most essential points necessary to produce the results wanted.

It will also be necessary to remark that giving too much or too little relief to a reamer will tend to produce unsatisfactory results. Too much relief invariably causes a reamer to chatter. Too small relief, again, will make the reamer very short lived, and will cause it to bind in the hole. In this connection it might be mentioned that the flat relief, although mostly used, is not the most desirable or the ideal one, because the cutting edge is not properly supported. In the writer's opinion the relief producing the best result is the one drawn in full lines in Fig. 2. The difference between this relief and the flat is obvious from the cut, where the latter

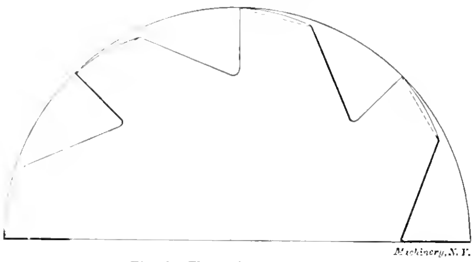


Fig. 2. The Relief of Reamers.

has been shown in dotted lines. This special relief, called eccentric relief, to my knowledge being used only by two prominent tool manufacturers, tends to add to the reamer's capability of producing a smooth hole.

Formulas for the principal dimensions of hand reamers, are given, together with a table figured according to the formulas given. For the diameter of the shank no figures are given in the table, as on any size reamer the general rule to make the shank very slightly below (0.001 to 0.002 inch) the diameter of the reamer may be adopted. The part of the shank which is squared should be made enough smaller in diameter than the shank itself, so that when applying a wrench no burr may interfere with the reamed hole.

Figures for the diameter of the guide will not be found in the table as here no general rule could be given. For different metals it is obvious that different amounts should be left for the reamer to cut. As a rule for all around work the writer would recommend to make the guide (viz., the amount to ream) from 0.005 to 0.007 inch smaller than the reamer for diameters up to 1 inch, and from 0.008 to 0.012 inch smaller for diameters from 1 to 3 inches. At the upper end of the guide there is a tapered portion (shown exaggerated in the cut) extending from about ¾ to ½ inch.

In all formulas the diameter of the reamer has been considered as the starting point. In the formulas:

A = diameter of reamer.
B = total length.
C = length of flute.
D = length of shank.
E = length of squared part.
F = size of square.
G = length of guide.

For reamers from 1/16 to 1 inch diameter the following formulas are used:

$$B = 7A + 1\tfrac{3}{4}$$
$$C = 4A + \tfrac{5}{8}$$
$$D = 3A + 1\tfrac{1}{8}$$
$$E = \tfrac{1}{2}A + 3/16$$
$$F = \tfrac{3}{4}A$$
$$G = \tfrac{3}{4}A + \tfrac{1}{8}$$

For reamers from 1 1-16 inch to 4 inches diameter, the following formulas are used:

$$B = 3A + 6$$
$$C = 1\tfrac{3}{4}A + 3$$
$$D = 1\tfrac{1}{4}A + 3$$
$$E = \tfrac{1}{2}A + 3/16$$
$$F = \tfrac{3}{4}A$$
$$G = \tfrac{1}{2}A + \tfrac{3}{8}$$

In the table some dimensions are given in even sixteenths when the formulas give uneven values.

As was mentioned before, the best way to obtain a good hand reamer is to have the cutting edges irregularly spaced. This difference in spacing may be made very slight. The manner in which it is usually done is to move the index-head, in which the reamer is fixed, a certain amount more or less than would be the case if the spacing were regular.

I have added a table below to be used as a guide for those not familiar with doing work of this kind, which gives the amount that the index-head should be moved more or less than would be the case for even spacing. The figures designate the number of holes to move in the certain index-plate used in each special case. It is, of course, understood that this table is only given as an example of how tables of this kind may be worked out, and there are, of course, an unlimited number of variations, provided that the "break" is large enough to serve the purpose.

* * *

One of the largest grain elevators in the world, the Canadian Pacific Railroad elevator D at Fort William, having a capacity of nearly 3,000,000 bushels, collapsed as a result of defective design. The subject of grain pressure in big bins is peculiarly interesting. It does not follow the law of fluid pressure, but the friction of the sides makes the vertical pressure on the walls a very important factor. With the old construction of wooden bins the vertical strength of the bins was always sufficient to take care of the vertical stress if made strong enough to resist bursting pressure. Not so, however, with steel bins, for they have much greater bursting strength than collapsing strength when loaded from above. Mr. J. A. Jamieson has made this the subject of exhaustive research and has deduced formulas for determining the vertical pressure. His work in this line was the subject of a paper read by him before the Canadian Society of Civil Engineers which was briefly abstracted in the March, 1904, issue of MACHINERY.

TABLE II. FOR IRREGULAR SPACING OF FLUTES IN REAMERS.

Number of flutes in reamer	4	6	8	10	12	14	16
Index circle to use	41	39	47	47	39	49	20
Before Cutting.	Number of Holes in Index Plate to move Spindle more or less than for Regular Spacing.						
2d flute	8 less	4 less	3 less	2 less	4 less	3 less	2 less
3d "	4 more	5 more	5 more	3 more	4 more	2 more	2 more
4th "	6 less	7 less	2 less	5 less	1 less	2 less	1 less
5th "		6 more	4 more	2 more	3 more	3 more	2 more
6th "		5 less	6 less	5 less	4 less	1 less	2 less
7th "			2 more	3 more	4 more	3 more	1 more
8th "			3 less	2 less	3 less	2 less	2 less
9th "				5 more	2 more	1 more	2 more
10th "				1 less	2 less	3 less	2 less
11th "					3 more	3 more	1 more
12th "					4 less	2 less	2 less
13th "						2 more	2 more
14th "						3 less	1 less
15th "							2 more
16th "							2 less

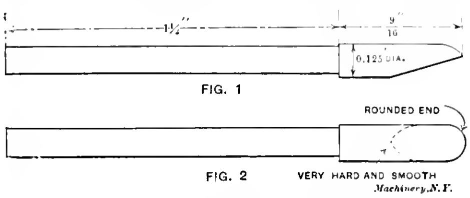
LETTERS UPON PRACTICAL SUBJECTS.

A REAMER FOR ACCURACY AND SPEED.

Editor MACHINERY:

To those interested in the manufacture of small steel parts, the following may prove of interest: It has been required of me to produce, in large quantities, parts of machines, the all-important point in their usefulness being accuracy of holes, perfect in size and very smooth, with a free working fit on a standard plug gage, while a gage 0.0003 inch larger must not enter. This quality of work has to be kept up uniformly, and not with here and there a lot with holes 0.0005 to 0.001 inch larger. The reamer shown in two views, Figs. 1 and 2, has been filling the bill for four years; it is extremely simple to make and inexpensive.

To make a reamer of this type use drill-rod about 0.002 inch larger than the hole desired; cut to the length required and round cutting end as shown, finishing very smooth; then



A Reamer for Holes in Thin Plates.

harden, dipping the reamer into mixture of one-third muriatic acid and two-thirds water; after this warm the tool to a degree that will sizzle water when dropped on it. The reamer *must* be hard and the above mixture will make it so. Lap with flour emery to size, using a reliable lap to produce a high finish and polish the round end nicely. Grind a flat diagonally across the point as shown at *A*, and the reamer is ready to use. When dull, grind as before.

This reamer is practical for reaming 3-16-inch holes and smaller in stock 1-16-inch thick and less, and will do good work in 5-32-inch stock. I have used one of these reamers in 0.050 inch steel stock for six months (continual use) with the work still up to gage and handling 2,500 pieces per day.

All work must be rough-reamed first, leaving not over 0.002 inch to finish and plenty of good oil must be used on every piece. If used dry for one hole only, the reamer may cut large from metal being burned on, though a glass may be required to see it. This may be carefully stoned off without injury to tool.

L. S. B.

A MECHANIC OF RESOURCE.

Editor MACHINERY:

Speaking of the various ways of applying for a "job" as a machinist journeyman and keeping it, reminds me of a man of my acquaintance, who walked in the shop one day about 8 o'clock in the morning and asked the foreman to give him a trial as a first-class all-around machinist, whereupon the foreman asked him what he could do, and he replied, "I learned the trade in a one-horse job shop, and I can do anything from turning a handspring down to splitting a corkscrew."

The foreman (with an inward chuckle) said, "I will just try you once for fun. When can you begin?"

"I am ready now," the man replied.

"But where are your tools?" inquired the foreman.

"Here they are," he replied, producing a two-foot rule, a one-pound hammer, and a pair of ordinary (firm-joint) outside calipers.

"Well, you may go and set up that portable engine frame on the 60-inch planer over there, and plane it up; here are the blueprints," the foreman replied.

To the surprise of us all he used his outside calipers for a surface gage, also as a scratch gage, by using some smooth wooden blocks in connection with it. Then he needed a hermaphrodite to strike some centers, etc., so he picked up a piece of stiff wire, sharpened it, and with a piece of string tied it to one of the caliper legs, and made it answer for that tool. A little later he wanted a divider, so he sharpened another piece of wire and tied it to the other leg, and he had a passable divider. After planing off the surface for the steam chest cover he wanted a depth gage for the valve seat. This he made by setting the washer and one point of the caliper on the first surface and using the other leg to swing and get his depth, thus a depth gage was made. A little later on he wanted an inside caliper to get an inside measurement, so by sliding the caliper points past each other he produced the desired tool. Then the thickness of the cylinder wall came up for discussion, and the man picked up a two-inch gage block that happened to be handy and by laying it on the cylinder outside, he set his outside calipers to the block and bore, so by subtracting the two inches from it he had the thickness, the same as though he had used an expensive transfer caliper. A few minutes later he discovered a slotted head screw working out of the planer tool-head, so he used his calipers for a screwdriver to tighten it up with. When he came to plane off the flange for bolting to the steam pipe he wanted to lock the tool-head to the cross-rail; he could not find the wrench to fit the setscrew, so he shoved the caliper legs together until they fitted the setscrew and thus used it as a monkeywrench.

All this took place before noon, and during the noon hour the "new man" explained to us that he had used that particular pair of calipers for many years, and also showed us how he had used it for a height gage, a draftsman's curve, bevel gage, thickness gage, thread tool gage, drill grinding gage, tap wrench, vise, counterbalance weight, ice tongs, etc., for many other odd jobs too numerous to mention.

As the days and weeks wore on we all came to respect this man very much for his great ability to cope with any job or occasion that presented itself. Nevertheless I do not exactly fancy the salute he gave the foreman when he was asking for a position, and I dare say that if any other man had asked with the same words he would have been flatly refused.

My object in telling you about this is to show many of your readers how the competent mechanic has almost no limit to the tools he has at hand. I considered that man to be a good sample of mechanics, and the word *mechanic* infers a great deal more than some people imagine; it certainly means more than machinist, because a great many machinists are not *mechanics*.

STEEL.

THE "SHORT" COUPLING.

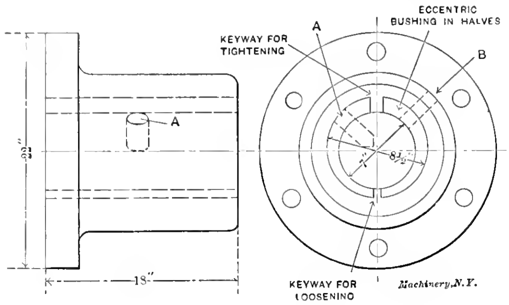
Editor MACHINERY:

About thirty-five years ago Mr. E. G. Short, of Carthage, N. Y., invented and, I think, patented a coupling for shafting. As the company organized for its manufacture has long since gone out of business and the patent has expired, I can now tell of an experience with it without appearing to advertise it. I once witnessed a very severe test of the power of this coupling to hold and drive without slipping, and because of the ease with which it may be put on shafting in the mill without removing it from position I think that some of the readers of MACHINERY will be interested in a description of the coupling and the incident referred to.

The place where the coupling was applied, and one that I consider was a hard test of its efficiency, was in a large steam sawmill driven by a 400 horsepower engine. The mill was able to saw a boat-load of lumber in twenty-four hours. The engine was directly connected to the lineshaft, which extended throughout the entire length of the mill, driving four gate saws, an edger, lath mill and butting saws. Upon starting up the mill one spring it was discovered that the coupling connecting the engine shaft to the lineshaft was loose; it had worked loose the previous season and had been repaired by a turned bolt, driven tightly through a drilled and reamed hole in both shaft and coupling, and riveted over on each end. This job had worn loose again, but when the mill was started in the spring the demand for lumber was so great that the owners wanted to start without taking time for removing the shaft, as seemed necessary to give it a thorough repair. They thought that the logs in the pond would soon be cut up and then there would be a dry time when the lineshaft repairs

could be made without loss of sawing, but the water remained high all summer, and no available time came. The shaft became so badly worn that it was absolutely necessary to tighten it, and the first Saturday night in November the shaft was taken up and an extra keyway cut in the shaft and coupling. Two new keys were fitted, the loose shaft and coupling were bushed with sheet iron, and the keys were driven tight. A week of sawing was accomplished with this repair, but the next Saturday night found it loose again—a horrible job. The mill was kept going by five or six repetitions of this repair, spending from Saturday night until Monday morning each time. At last Jack Frost cut off the supply of logs and then there was an opportunity to make a permanent repair.

The coupling that made the trouble was on the second length of the main lineshaft, consequently it drove all the machines in the mill. The half coupling that was keyed on the first



The "Short" Coupling.

length of lineshaft or the countershaft of the engine remained tight and in good order. The couplings were of the hub and plate type held together by turned bolts. It was determined to replace the loose coupling by a new half coupling of the "Short" type. One was made of a length of hub sufficient to reach beyond the 9-inch section of the worn shafting onto 9 inches of unworn shafting, making a cast-iron cylinder about 18 inches long, with plate to match the good coupling on the countershaft. The coupling was cored out the first 9 inches of its length from the joint and the rest of its length was bored $8\frac{1}{2}$ inches diameter, but eccentric with the periphery. A cast-iron bushing was turned to fit the bore and it was bored to fit the shaft, which was 7 inches diameter. It, however, was bored eccentric the same amount as the coupling was bored out of the center, so that when it was in place the coupling and the shaft would run true. This bushing was split apart by planing through the thick and thin sides. The opening on the thick side was made 1 inch wide, and $\frac{3}{4}$ inch wide at the thin side, but both of these spaces or keyways were $\frac{1}{8}$ inch narrower at the inner edges of the bushing. Thus the bushing when cut apart made two half-circle wedges or keys about 1 inch thick at one side, or properly, end, and $\frac{1}{2}$ inch thick at the other. Steel keys with gib heads were made to fit the opening sideways, the large key being made to tighten the bushing in place after being driven home, but the smaller key being made only to loosen the bushing. Holes for dowel pins $1\frac{1}{2}$ inch diameter were drilled through the bushing and into the shaft at *A* and through the coupling and bushing at *B*, and dowels were turned and driven into these holes. Before bolting the couplings together the bushings and large steel key were slightly oiled and the key was driven hard home. It will be seen that because of the dowels the coupling and one half-bushing, and the shaft and the other half-bushing will tighten in opposite directions, the taper of the bushings and the drive of the setting-up key causing them to act practically like keys, and when wedged tightly in place the whole fitted together very much like a pressed fit.

This coupling drove all the machinery in the mill for about four years and was as tight when the mill was dismantled as when first put on. For ordinary line shafting, not too large, which rarely requires taking apart, the coupling may be a continuous sleeve without parting at the ends of the shafts. To show the power of the coupling to drive, the following experiment was made when it was first designed: A $1\frac{1}{2}$-inch coupling as tightened onto two short pieces of shaft, one of which was secured to a heavy casting, and to the other was bolted a long beam. After twisting the shaft until it was simply a mass of disorganized fibers outside the coupling, the screws were loosened and the coupling was easily removed from its hold on the shafts. For very light shafting the bushing may be tightened by hollow setscrews with square holes for a wrench. The setscrews have conical points which fit into countersunk places in the bushings, but even in small couplings the key is best.

C. E. MINK.

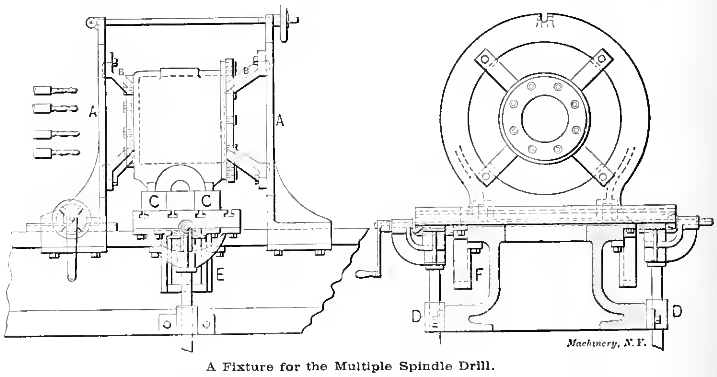
Syracuse, N. Y.

HOLDING THE WORK ON A HORIZONTAL MULTIPLE SPINDLE DRILL.

Editor MACHINERY:

The enclosed sketch of a double multiple drilling machine we think may be interesting to some of your readers who are interested in rapid drilling and good fixtures for the same.

The shop management having purchased a thirty-two-spindle horizontal drilling machine (sixteen spindles mounted in drill spindle head at each end of the bed, the drills pointing toward the center of the bed), principally for underwriter steam fire pump cylinders and centers, it became necessary to make provision for a work table, holders for drill jigs, etc., nothing of this sort having been provided for when the machine was ordered. We first designed and built the elevating table as shown in the cut, this being much the same as a horizontal boring machine elevating table, and elevated by means of right and left-hand square thread screws, one at each end of the table. A slide, *E*, of sufficient length to allow table to be elevated six inches is bolted to the under side of table at each end, just outside of bed of machine. The slide is a working fit in a three-sided guide, *F*, bolted to the under side of the overhang of the machine bed, and is plainly seen in the right-hand view. A strongly ribbed yoke connects the table and elevating screws, the elevating gears being between the yoke and the table. The pitch of the screws is two per inch, and the ratio of pinion and gears is four to one. The elevating



A Fixture for the Multiple Spindle Drill.

screw nuts, *D D*, are bolted to the base of the machine bed, as shown.

Two drill jig holders, *A A*, are mounted on machine bed, one on each side of the table, and are alike except that the right-hand one is placed in about the endwise position on the machine bed desired, and is clamped to the machine bed, while the one on the left hand is movable along the machine bed by means of a rack and pinion, the pinion shaft being squared at the end to receive a suitable crank. After the left-hand *A* has been brought up so that the drill jig is in position against the work, it is securely locked by means of the hand wheel shown in the left-hand view. *B B* are the drill jigs, and are, of course, made to suit the different castings or work (in this case being used with an 18-inch fire pump steam cylinder).

It will be noticed that the valve face of the steam cylinder rests upon parallels *C C* and, of course, much larger work can be accommodated when the parallels are removed. In setting a cylinder into the fixture, the proper height of table is

obtained when the left hand *A* is moved forward until the drill jig is against the cylinders, when a shoulder on the cylinder enters a recess in the drill jig; then the cylinder counterbore is forced upon a shoulder on the right-hand drill jig, centering each end perfectly. *A* and *A* are then firmly clamped together at the top by means of a swing bolt and hand wheel, and all is now ready to drill twenty or more holes at the same time. No attempt is made to show the drilling machine with the exception of a portion of the bed. The leading ends of the cylinder drills are shown as about to enter the drill jig bushings. Brackets *A A* are fitted and scraped to the machine bed, and are bored in place, and all drill jigs are finished with tongue to fit the bore of *A* and are bolted and doweled to it, as shown.

When the machine, fixture, etc., are set for a certain sized cylinder, the drilling can easily be done at the rate of twelve per hour. The one drawback to an otherwise good drilling machine is that the setting up of the machine consumes too much time when only a few pieces are to be finished, and "Jim" has often said he preferred to drill a single or a few pieces under an ordinary radial drill. A large enough number of pieces are seldom gotten together to make the machine as profitable as might be desired, and on this account it has been dubbed "The White Elephant." Of course other work besides pump cylinders is done in the machine when anything like a goodly number is gotten together. "B."

A HOLLOW MILL AND JIG.

Editor MACHINERY:

The faces *D*, *E*, *F* and *G* of the arm shown in Figs. 1 and 2 had been finished as a first operation, but on the other end of the arm is a boss on which the faces *A* and *B*, and the hole *C* had to be finished true in relation to faces *A*, *E*, *F* and *G* and at a certain distance therefrom. This last operation on these arms had always been done on the faceplate of an engine lathe, but a lathe of large swing, and therefore of heavy construction, was necessary and as the diameter of the boss had to come within a limit of 0.001 inch, the lathe was inconvenient and the time unsatisfactory. To obviate the necessity of swinging the piece in the lathe, the hollow mill shown in Figs. 6 and 7 and the jig shown in three views, Figs. 3, 4, and 5 were designed. With these appliances, the work was done in the drill-press with a reduction of 50 per cent in time over the old method. Moreover, not as highly skilled labor was required to do the work.

The jig for holding the arm includes the body *G* which carries the hardened bushing *H* for guiding the mill. At the opposite end and on the underside a boss was turned to fit the faces *E* and *F* on the arm. This boss was for locating the arm in the proper position, the arm being clamped by means of the bolt *I*, the split strap *J* and the nut *K*. The bolt *I* is prevented from turning by the headless screw *h*. The set-screw and check-nut *O* are used for locating the end of the arm sideways. The hook-bolt *L* and knurled nut *M* are used to resist the pressure of the mill when cutting.

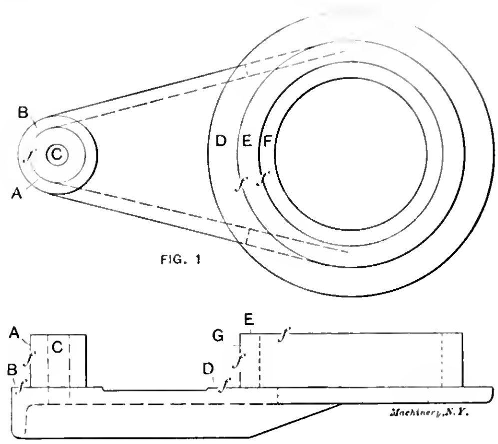


FIG. 1 FIG. 2

The Piece to be Milled.

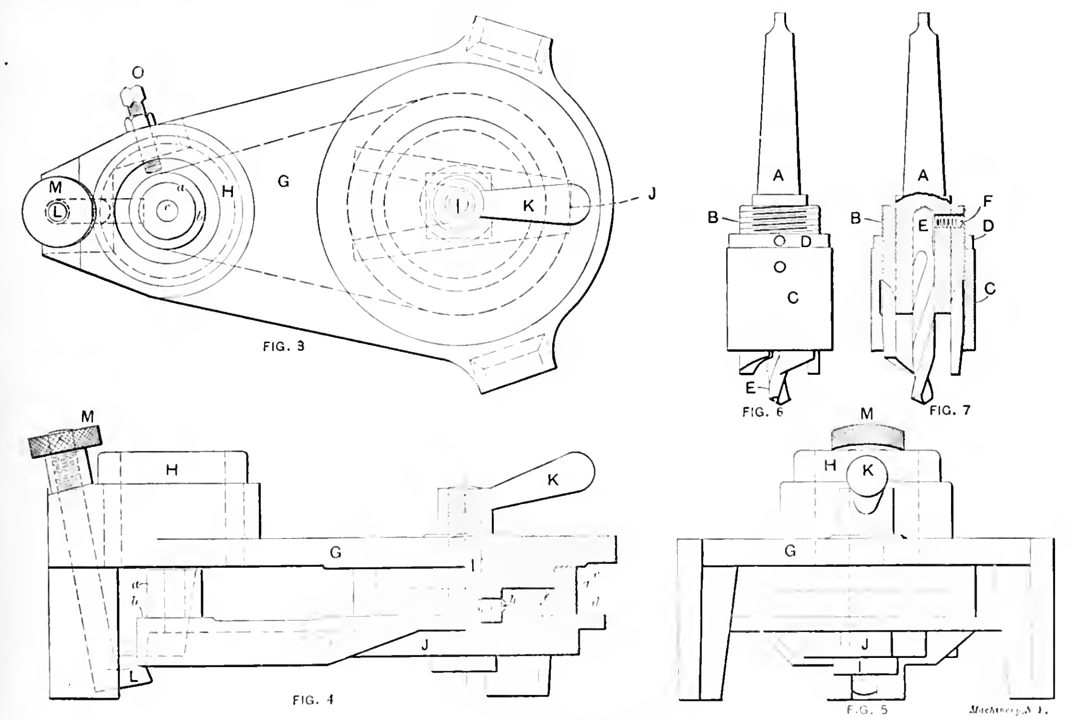


FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7

Fixture and Tools for Hollow Milling.

The hollow mill is made up of the body and shank *A* onto which is driven the cutter or hollow mill *B*. The upper end of the cutter is externally threaded and the lower part is slightly tapered toward the end. The shell *C* is fitted over the cutter *B* and the upper part is internally threaded to fit the thread on the cutter. The lower end of the shell is bored to the same taper as the cutter so that when the shell is screwed upward it will partly close the cutter teeth inward, the same as a split clamp. The hole in the cutter is made slightly

larger than the shell to be milled, so that when the mill is closed to the right size it will give proper clearance on the inside to the cutting edges. The shell C is locked in position by check nut D, both check nut and shell being provided with holes for adjustment with a spanner. It is needless to say that the shell is hardened and ground true with the hole in the mill. For drilling the hole C in the end of the arm at the same operation, a common twist drill E is fitted in body A and held there by the headless screw F. CHARLES THIEL.

Lawrence, Mass.

BEAM COMPASS CONVERTED INTO A HATCHET PLANIMETER.

Editor MACHINERY:

In the September issue (Engineering Edition) you published an article on the hatchet planimeter. I had been using a borrowed one and as the results were very satisfactory I made up my mind to make one. But before I had time to secure the material for doing so, I happened to be using my beam compasses, which are made like the illustration Fig. 1, and the thought came to me, Why not try a hatchet end in it? This was very quickly made and soon tested.

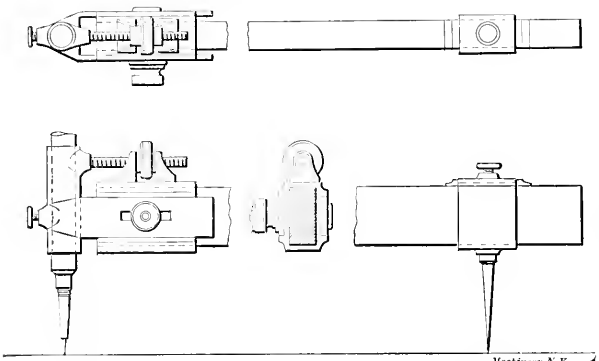


Fig. 1. A Beam Compass which was used as a Planimeter.

I find the areas given by this to be very close, and the way I used it, of course, hardly needs any explanation. The hatchet being inserted in the end where the pencil is shown in the drawing, and the point being set exactly 10 inches away. This is very easily done, as the rod from which the hatchet was made is exactly 5-16 inch diameter. So measuring from the edge 10 inches minus 5-32 inch gives exactly 10 inches

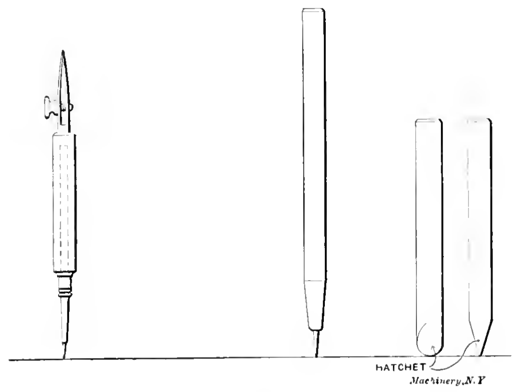


Fig. 2. The Compass Attachments.

between centers. In order to get the line of the hatchet edge true with the center I lay it down on a steel straightedge sideways, which lines up the edge, and then the binding screw shown in front is set up.

The beam compass is one that I made ten years ago; it was copied from one that was made for doing very accurate mill work, and the design allows the application of the hatchet very well. The long rod with the point is a very useful tool, also, for measuring, say, a radius on two levels, such as patterns sometimes have. The rod is let down on the point to be measured and then drawn up to be laid on the scale for reading the length; or, the reverse, the length may be taken first and then the rod let down to scratch the radius.

The drawing shows the trammels as made for an aluminum bar, but as I use mahogany bars of different lengths there is a gib and a setscrew on the under side to keep the head tight and prevent movement. ERNEST J. LEES.

Cleveland, O.

MAKING BLUEPRINTS FROM TYPEWRITTEN ORIGINALS.

Editor MACHINERY:

I had a lot of data and tables of standards of which I wanted blueprints, and as it would take a lot of time and be expensive to have a draftsman make them in the usual way, the idea occurred to me to try to do it on the typewriter, as it would be quicker, neater, and less expensive. I did considerable experimenting before I found the right combination to give the best results, but will give the results of my final experiments only. What is desired is a sharp, black copy that will make a good, clear blueprint, and the method of making these originals is as follows:

Upon a sheet of copy paper such as used for manifolding, lay a sheet of carbon paper face up; take a piece of tracing paper and lay it on the carbon paper and put them in the typewriter in this order so as to write on the tracing paper. This will give you a copy on the front and back of the paper that will be strong enough to take blueprints from if the following is closely observed.

A good black ribbon is required, a new one if possible, but do not use one that has been used for any length of time and that will not strike up a good sharp black letter; a good carbon paper is also required. I use a new sheet every time so as to get a good uniform letter; the carbon sheet can then be used on regular manifold work so that we lose nothing by it. The paper used for backing is the regular copying paper used for manifolding, but this is immaterial and can be made to

This is a sample and is on "Series Paper"
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abcdefghijklnmopqrstuvwxyz;,.-
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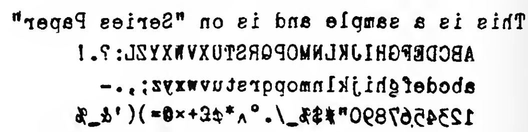


Reproduction of Typewritten Original. Obverse and Reverse Sides.

suit different machines. I have found that the best paper for the original is a good tough grade of thin tracing paper. I used Keuffel & Esser's "Series" brand, which takes the ink and carbon well and from which mistakes are easily erased without damaging the paper. I had some trouble to find a carbon paper that would give a good black uniform impression, but I finally obtained some of the "Pilot" brand from the United Carbon Company that suited this purpose exactly.

I am sending you samples of the paper that I used on this work and some of the blueprints that have been taken from some of the tables. The table of decimal equivalents, was taken from an original made on regular manifolding paper and as you will see is a little cloudy. The other print of wire gages was taken from an original made on "Series" paper as described above and as you can see is a good clear, sharp print. I have tried this method of making originals on tracing cloth with fair results, but it is not so easy to erase on as the tracing paper.

In making erasures use a soft rubber, as an ink eraser will rough up the surface of the paper, and when the character is struck over, it will smut. To correct mistakes, turn up the paper and place at the back some smooth object (say a piece of glass or a celluloid triangle) and erase on the face, then place it on the face and erase on the back; the desired character can then be struck in.

The lining can be done either before or after typewriting. The way that I do it is to put the sheet of paper in the machine and space off with the space bar and strike the dot, then space vertically with the carriage shift key and strike the dot, taking care to keep the dots outside of the margin of the finished sheet, then take the paper from the machine, rule the lines, put it back in the machine with the carbon paper as described above and fill in the numbers and characters as desired. Care must be taken to have a good uniform original if good prints are desired. I have tried this method on several makes of machines, but have got the best results on the Hammond, as it gives a perfectly uniform impression.

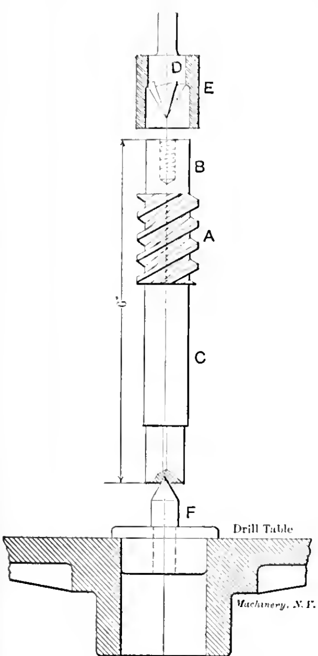
W. H. A.

[The blue print of wire gages is clear and plain, and that of the decimal equivalents is good enough for all practical purposes. Two photographic reproductions, slightly reduced, are shown herewith of a small typewritten original, front and back, and the fact that it reproduces in this manner clearly is a guarantee that it will blueprint well, provided the printing is done on transparent paper such as any good tracing paper or cloth.—EDITOR.]

DRILL-PRESS CENTERING DEVICE.

Editor MACHINERY:

Having a few hundred composition pieces to thread at *A*, we proceeded to run them on centers in the lathe, but found that the end, *B*, would not run true. It was necessary that the thread should be true with the parts *B* and *C*, which were already turned to a fit. The end, *C*, was centered true, but the end, *B*, was threaded internally, and not properly chamfered. Some pieces would run out as much as 1-32 to 1-16 inch, and we, therefore, had to find a way to get a true center in that end.



A Drill Press Centering Device.

Such obvious ways as using a steadyrest, universal chuck, etc., were considered, but they were all too slow to use on the quantity required. Finally, we hit upon the following: A piece of steel, *E*, was chucked and bored a tight fit for a standard four-fluted center reamer, *D*, and then counterbored a running fit for the end, *E*, of the composition piece, the outer corners being slightly rounded. This tool was then caught in the chuck of a small drill-press, and the lower center, *F* (which we use when centering shafts), was placed in the hole of the round table, directly under the tool. Then, by simply holding the piece with the hand, and just allowing the reamer to touch the hole, we were able to center the entire lot in about one hour, and with an accuracy to within 0.002 to 0.003 inch of truth, which was perfectly satisfactory. We were then enabled to thread the pieces without further trouble.

Newark, N. J. ELMER G. EBERHARDT.

SOLDERING.

Editor MACHINERY:

Soldering is usually considered a very simple job, but nevertheless it often gives the toolmaker or machinist considerable trouble unless he has had some previous experience. The following remarks may be an aid to some one who is "up against it."

Soldering "irons" are usually made of copper, as copper is easily heated and easily gives up its heat to the solder. The point of the iron must be "tinned." To do this properly, the iron should be heated hot enough to easily melt the solder; the point should then be quickly dressed with a smooth flat file to remove the oxide, and rubbed on a piece of tin through solder and sal ammoniac. The latter causes the solder to adhere in a thin, even coat to the point of the iron. A gas or gasoline blow torch, or a charcoal furnace is best for heating the iron, but a good, clean coal fire, well coked, will answer the purpose.

When in use, the iron should be kept hot enough to readily melt the solder. A cold iron produces rough work. This is where the beginner usually falls down. If possible, it is well to warm the pieces before applying the iron. The iron must not be heated too hot, however, or the tin on the point will be oxidized. The surfaces to be soldered must be clean. Polish them with sandpaper, emery cloth, a file, or a scraper. Grease or oil will prevent solder from sticking.

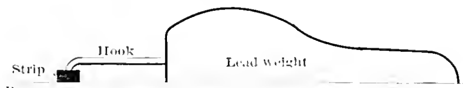
Some good soldering fluid should be used. A very good fluid is made by dissolving granulated zinc in muriatic acid. Dissolve as much zinc as possible in the acid. The gas given off will explode if ignited. To granulate the zinc, melt it in a ladle, and pour it slowly into a barrel of water. A brush or swab should be used to spread the fluid on the surfaces to be soldered. If the point of the soldering iron becomes dirty, it should be wiped on a cloth or piece of waste that has been dampened with the soldering fluid. O. L. LEWIS.

Indianapolis, Ind.

FLEXIBLE CURVES FOR DRAFTSMEN.

Editor MACHINERY:

You have occasionally had descriptions of flexible curves for draftsmen's use, but I do not remember to have seen any reference to the method employed by ship draftsmen for drawing curved lines. While most of your readers are familiar with the method, it may be new to some of the young fellows. As long ago as the sixties, when I was spoiling double-elephant paper in Chester, we used for ship-lines and other long non-circular curves flexible strips of wood about 3-16 inch wide and thick, which were held in position by "ducks' heads" of lead with bent-down iron points, somewhat as shown in the sketch. Several points in the curve being found by ordinates and each marked by a dot, one end of the strip was brought in the right place for commencing the line at one end, and



A Flexible Curve.

held there by the sharp downwardly-bent point of the steel hook, the strip brought to the next fixed point and similarly held, and so on to the end of the curve. Or, first, the middle was placed and then we worked toward both ends of the line alternately to right and left.

For holding small pieces of tracing-paper or cloth over the middle of a large drawing, when it was desired to trace only a small detail, and making holes in the drawing with drafting-tacks was not admissible, we held the transparent material in place with the same "ducks' heads," using small pieces of india rubber or of cork between the iron point and the tracing to make up for the height of the wooden strips with which the "ducks' heads" were normally used.

Hard rubber would be better than wood for the strips, if it were not for its property of soiling the drawings.

Hanover, Germany. ROBERT GRIMSHAW.

A DECEPTION THAT DID NOT WORK.

Editor MACHINERY:

Morgan, a young friend of mine, was, during his foreman's illness, filling the position, and was sent to inspect some special drilling machines ordered by his employers. In the specifications sent out by the firm a certain sized hole was required to be drilled out of the solid. Arriving at the toolmaker's, which was located some little distance away, he was received by the manager. After they had talked quite a while on things in general and machine tools in particular, he was conducted

to the machines. These were of the upright type. One machine was belted up for drilling, the others set up for testing as to the alignment, etc. Trammeling the tables from the spindle, Morgan found them within the limits stipulated, but the bases were all so very good he became a little suspicious. He had erected drilling machines himself. Casting around for anything which might affect the accuracy, his eye caught the wedges used to level up the machines. He kicked these away and gently pushed one under each corner with his fingers, just tight enough to take the weight. Then testing again, it was found to be not so good as before. The base had been, as he surmised, sprung into true by the wedges. He explained this to the manager, who was always hovering around, and there was a terrible row, the manager "jacking up" every one connected with the job. Going through the other machines (there were eight altogether) they found that two were sufficiently out of true to demand replaning. These he filed down at the corners as a guide to the planer and a check for himself. To Morgan's surprise, it was now nearly noontime. The manager took him out to lunch, but he insisted upon paying for himself, thinking it unwise to be under much obligation to them in case of future trouble. After lunch, the drilling test was to be gone through. From what he had seen of the machine, it looked short of power.

When they reached the machine, a cast-iron piece was clamped on the table and the operator was ready to drill it. To his surprise it took the cut all right, going right through the piece 3 inches thick at the speed stipulated. As he casually looked at the hole, the metal did not seem to have been annealed, a thing he had been warned against. While the test piece was being removed, he noticed a piece of wire about five-sixteenths diameter among the chips; it upset him considerably. He could have sworn it was not there when the cut was started, and it being there after suggested a fake. But what it was he could not think. While he was trammeling the machine which did the test, he was thinking, thinking very hard, how he could get around the deception which he felt sure was being practiced upon him. Not knowing what it was made it worse. Morgan made up his mind to have another piece drilled, an ordinary piece out of the shop if possible, but how to ask for it he did not know. Inspector's work was new to him, and he, at that time, couldn't bounce. Sending a helper for the manager, Morgan said he was sorry to give trouble, but his instructions were to have two machines tested for drilling, one of them picked out at random by him. The manager, after demurring a little, saying that they were all identical, and therefore what one could do they all would do, agreed to have another belted up, and suggested adjourning to his office while it was being made ready. Morgan went down, not because he wanted to—he wanted to watch them get it ready—but because he did not know how to refuse. However, after a while news came that the machine was ready, so they went up to it. A little thing Morgan thought was peculiar was that the position for the hole had been marked out and the center pricked. Why it should be so he did not know. The operator started the cut, which went all right. When the spindle had traveled about an inch Morgan stepped over and quickly stopped the feed and raised the spindle.

The deception was exposed; from the reverse side of the block a small hole had been drilled all but through, taking out the center of the hole. In the previous case they had evidently drilled the hole right through and plugged it with wire, an easy fit.

There is not much more to be told. Morgan cleared out as quickly as he could, made his report, and his firm refused the goods. They afterward, much to Morgan's disgust, bought the machines at a slightly lower figure. H. T. M.

JIM AND HIS DRAFTING ROOM.

Editor MACHINERY:

Jim came in to see me the other day. He was an apprentice boy under me eight or ten years ago, and before he had been in the shop six months I saw he was a good piece of stock and I pushed him for all he was worth. If you get hold of a good piece of material, whether it be steel or humanity, there is a pleasure in seeing the chips peel off and the finished product come out of the rough, and so it was with Jim. He was country, clean through, but he shook the hayseed out of his hair and did well.

He stayed out his three years as apprentice boy, and then he was put on the tool job. He seemed to have a natural aptitude for die work and knew just what a piece of metal would do, and what the tools should be to make it successful. He had left me to take a position in a large Western shop as foreman of the press and die work, and though I knew that he had made good and was well liked by the firm, I had never seen him since he left.

After talking over old times, and the whereabouts of the rest of the boys we used to know, I said: "Well, Jim, what is the worst thing you have run up against since you were here?" Jim thought a moment, then laughed and said: "Drafting, I guess, but I got over that all right, and I will tell you about it.

"You see, it was like this: I hired out to run the die and press job, and also do all the designing of the tools for the work, and though it gave me no more trouble than I expected, it kept me on the jump to get the sketches made so as to keep the die-makers working. I had done it for a year, and I knew that I stood 'ace high' with the firm, so I asked for a draftsman, and what do you suppose they said. That they had no draftsman they could spare out of the drafting room for die work, and also kind of carried the impression that dies didn't need to be drawn out on paper anyway. Well, I was mad clean through, but I kept on sawing wood.

"I had three or four bright young fellows, and one of them was going to night drawing school. I only had a 3 x 4-foot office, and I could not squeeze him in anywhere, and so I had to make other arrangements. The shop was very high in the walls, and over in one corner of the building there was a time office, through which the men used to come and drop their checks as they entered the works. This office was 20 x 20 feet and 8 feet high, with a good ceiling of matched boards. Well, I took and cleaned off the top and roof, and fitted up a long nice drafting table with a couple of electric lights, or rather I got two long extensions and ran them from the press lights up, so they would drop down over the drafting table. I also procured a roll of paper from the drafting room. Then I would sketch out the work in the office, call in the boy and explain to him what I wanted and have him draw it out to scale. He took to it as a duck takes to water, and soon would turn off a better job than I ever could. We had to use a ladder to get up there, and it was a pretty warm place, but otherwise it was O. K.

"It had been going along this way for several months, and one day the 'super' came in and saw the boy up there. 'What is that kid up there for?' said he. 'Oh, he is just making a sketch I didn't have room for down here,' I replied, and that was all there was said about it. I got the drafting done, the kid got a lot of good experience, and the company got the goods and paid for them, even if it didn't get in the bill. I do not know that it was just honest, but I don't care much—I had to do it, or I would have gone 'bug-house.' Did I do right?"

"Well, Jim, the company evidently got the value of their money, and there don't seem to have been any graft in it, so I think it was all right."

"There was one thing more I run up against, and though the methods I used were successful, I do not recommend them. One of the constructing engineers had a very haughty manner. He was an A1 man, but he used the rest of us foremen like dirt. One day he was passing through the room, and I said as he came by: 'Mr. Jones, I would like to see you a moment.' No reply. 'Mr. Jones!' Still no reply. 'Go to h——!' Jones wheeled around, and said: 'What was that you said?' 'Oh, you heard that time, did you? Well, never mind. Don't stop now, go right ahead; but I will find out, if I speak to one of my superiors in a respectful manner, whether I am to get a civil reply or not.' Jones came back and stayed an hour or more, and that was the last of my trouble in that direction." I am not advocating Jim's way of doing the jobs, but only tell of it to show what it is sometimes necessary to do in order to get there. A. P. PRESS.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO MAKE A BELT PULL.

Some time you may have a hurry-up job on a machine—perhaps you may never have had one—but should it fall to your lot to find that your belt will not pull the cut you desire, just find a piece of tar soap and hold it on the inside of the belt while it is running, and the result will surprise you and will materially aid you to finish the job on time.

Rochester, N. Y. CARROLL ASHLEY.

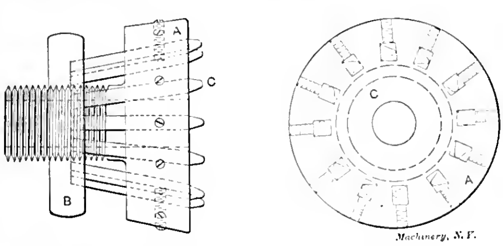
TO REMOVE BROKEN TAPS.

To remove a broken tap from cast iron the hole should first be thoroughly cleaned out by means of a small squirt gun filled with kerosene. All small broken pieces of the tap can be removed with a pair of tweezers. Then the tweezers, which should be as large as possible, should be inserted between the hole and the flutes of the tap and by slowly working back and forth and occasionally blowing out with kerosene, the broken piece is easily released. A through hole, of course, simplifies matters somewhat H. J. BACHMANN.

New York.

AN INSERTED TOOTH CUTTER.

Having noticed many styles of inserted tooth cutters illustrated from time to time I here submit a sketch of one of which the cost of making is not very great. The head, *A*, has holes into which the cutters are inserted, these to vary in size or number to suit the work; the cutters are held in the head by headless setscrews. The head has a taper hole running



clear through, into which an arber is to be driven. The collar or adjusting nut, *B*, is grooved to allow the end of the cutters to enter. Having made several of this type of cutter and found them satisfactory, I submit same hoping it may be of some use to others. G. E. WHITE.

Ridgway, Pa.

TO HARDEN A HAMMER.

To avoid the danger of "checking" a hammer at the eye, heat the hammer to a good uniform hardening heat and then dip the small end almost up to the eye, and cool quickly as possible by moving about in the hardening bath; then dip the large end. To successfully harden a hammer by this method you must work quickly and cool the end dipped first enough to harden before you lose the heat on the other end. Draw the temper from the heat left about the eye. The result is a hammer hard only where it *should* be and free from "checks."

I. W. ANTANO.

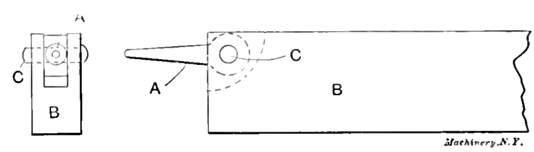
TO MEASURE A STANDARD V-THREAD WITH A MICROMETER.

A U. S. standard or Sellers thread may be accurately measured with a micrometer by the aid of three wires, preferably Stubbs steel. Select a diameter of wire that will lie in the thread nicely and project above the tops of the thread. Use two wires on one side in adjacent V's and one wire on the opposite side, so as to be in the middle plane between them. For convenience these wires may be sharpened and stuck into a block of soft wood, two on one side of the screw and one on the other. Then, having gotten the diameter as measured over the top of the wires, the thread diameter may be obtained by the following rule: From the diameter as measured over the wires, subtract three times the diameter of the wires. To the remainder add the quotient obtained by dividing 1.5155 by the pitch. For example, suppose that a 14-pitch screw is measured in this manner, using wire having a diameter of 0.053 inch, and the diameter over the wires is found to be 0.5507 inch. Subtracting 3×0.053, or 0.159 from 0.5507, leaves 0.3917. To the remainder add $\frac{1.5155}{14} = 0.1082$, giving the diameter as 0.4999, or ½ inch. ERNEST KROFT.

Cincinnati, O.

TO LINE UP LATHE CENTERS.

To line up lathe centers I use the simple and inexpensive tool shown in the cut. The stock is made of a short piece of bar iron of the same size section as the tool steel used for my lathe tools. The stock, *B*, is milled out as shown by the dotted lines in the side view to receive the pointer, *A*, which is held in position by the cross pin, *C*. The pin should be a close fit in the pointer so that while it can move freely there will be no shake. To use the tool turn a short space on the end of the piece which is to be turned straight, being careful to turn it perfectly round. Now, put the little indicator in

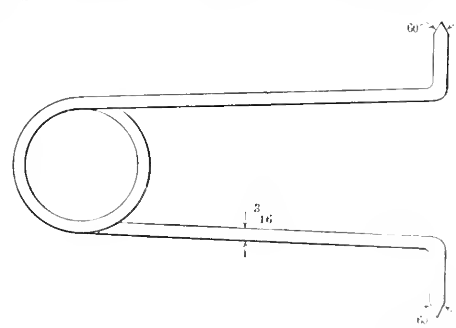


the tool post, and with the turned part next to the face plate, adjust the cross slide so that as the pointer is wiggled up and down, the work can just be felt. Reverse the work on the lathe centers and throw the pointer up out of the way and, without moving the cross slide, run the carriage along so the pointer may again be tried on the turned part of the piece. By adjusting the set-over screws until the pointer can be just felt against the work, the tail-stock will be set so that the lathe will turn straight. The tool is also very handy for many other purposes which will continually suggest themselves, and may be used advantageously on the planer.

I. W. ANTANO.

THREAD CLEANER FOR CHUCKS AND FACEPLATES.

The practice of cleaning out the threads on chuck and other faceplates every time they are screwed on the spindle is very necessary to maintain the accuracy of the chuck and should therefore not be neglected, especially by apprentices. The only instrument necessary is a piece of 3-16-inch drill rod bent into the shape of a safety pin and having its two ends bent outward with the points filed to 60 degrees, as shown in cut. Inserting this little tool between the threads and moving



around by hand insures the removal of all dirt and chips that have accumulated therein. In this connection it is also well to remember that after removing a chuck or faceplate from the spindle it should be laid away face down or with the chuck jaws resting on bench or floor, thus keeping the chips away from the thread as much as possible.

New York. H. J. BACHMANN.

[Filling the thread bore with waste or a plug of wood is a practice largely followed by careful machinists.—EDITOR.]

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

123. SHELLAC CEMENT.

Shellac is the basis of most adhesive cements. A good one is made by thickening shellac varnish (shellac dissolved in alcohol) with dry white lead, mixing the two with a putty knife on a piece of glass. W. H. SARGENT.

St. Johnsbury, Vt.

124. PACKING FOR GASOLINE PUMPS.

For packing pumps on gasoline engines use asbestos wick-packing rubbed full of regular laundry soap; it will work without undue friction and will pack tightly. Common rubber-packing is not as good, as the gasoline cuts it out. A. A.

125. TO DELAY THE SETTING OF PLASTER-OF-PARIS.

Citric acid will delay the setting of plaster-of-paris for several hours. One ounce of acid, at a cost of about five cents, will be sufficient to delay the setting of one hundred pounds of plaster-of-paris for two or three hours. Dissolve the acid in the water before mixing the plaster.

Indianapolis, Ind. OTTO L. LEWIS.

126. TO REMOVE BURNT OIL FROM HARDENED STEEL.

To remove excess oil from parts that have been hardened in oil, place the articles in a small tank of gasoline, which, when exposed to the air, will dry off immediately, allowing the part to be polished and tempered without the confusing and unsightly marks of burnt oil. H. J. BACHMANN.

New York.

127. SUBSTITUTE FOR CEMENT ON GRINDER DISKS.

A good substitute in place of glue or various kinds of cement for fastening emery cloth to the disks of grinders of the Gardner type is to heat or warm the disk and apply a thin coating of beeswax; then put the emery cloth in place and allow to set or cool under pressure. G. HUBER.

Kansas City, Mo.

128. MENDING CEMENTS FOR CELLULOID.

To mend broken triangles and other celluloid articles use 3 parts alcohol and 4 parts ether mixed together and applied to the fracture with a brush until the edges become warm. The edges are then stuck together and left to dry for at least twenty-four hours.

Camphor, 1 part; alcohol, 4 parts. Dissolve and add equal quantity (by weight) of shellac to this solution.

New Britain, Conn. F. L. ENGEL.

129. LUBRICANT FOR HIGHSPEED BEARINGS.

To prevent heating and sticking of bearings on heavy machine tools due to running continuously at high speeds, fill an oil can with a good spring bottom (the "Gem" oiler preferred) about one-eighth full of Dixon's flake graphite, and the remainder with kerosene oil. As soon as the bearing shows the slightest indication of heating or sticking, this mixture should be forcibly squirted through the oil hole until it flows out between the shaft and bearing, when a small quantity of thin machine oil may be applied. H. J. BACHMANN.

New York.

130. TEMPERING COMPOUND FOR STEEL.

The following receipt for a tempering compound I have found very useful when it was impossible to procure a good grade of steel. This compound will be found specially good for cold chisels, center punches, lathe, flat drills, etc., and in fact almost any tool not having irregular forms or thin cutting edges. To 6 quarts of good clear rain water add 1 ounce of corrosive sublimate and 2 pints common salt. Stir until thoroughly dissolved. This compound seems to both harden and toughen steel; the tools are dipped and drawn in the usual manner. HERRMANN G. KROEGER.

Louisville, Ky.

131. RED WRITING FLUID FOR BLUEPRINTS

In answer to the request of D. C. T. in the December issue for writing fluids for blueprints, I would recommend him to take a piece of common washing soda the size of an ordinary bean and dissolve it in four tablespoonfuls of ordinary red-writing ink, to make a red fluid. The only way I know of to keep it from spreading too much is to use a fine pen to apply it with, and write fast so as not to allow too much of the fluid to get on the paper, for it will continue eating until it is dry.

H. E. W.

132. COLORED INKS FOR BLUEPRINTS.

Replying to the inquiry by D. C. T. in the December issue for red and white solutions for writing on blueprints, dissolve a crystal of oxalate of potash about the size of a pea in an ink bottle full of water. This will give white lines on blueprints; other potash solutions are yellowish. If this shows a tendency to run, owing to too great strength, add more water and thicken slightly with mucilage. Mix this with red or any other colored ink about half and half and writing may be done on the blueprints in colors corresponding to the inks used. W. H. SARGENT.

St. Johnsbury, Vt.

133. ANTI-FRICTION METAL.

An anti-friction metal of most excellent quality and one that I have used with success for a bearing on an internal grinding shaft, which was 5-16 inch diameter, 7 inches long, and 5 inches in the bearing, and run at a speed of 36,000 R. P. M. is made as follows: 17 parts zinc; 1 part copper; 1½ part antimony; prepared in the following way: Melt the copper in a small crucible, then add the antimony and lastly the zinc, care being taken not to burn the zinc. Burning can be prevented by allowing the copper and antimony to cool slightly before adding the zinc. This metal is preferably cast into the shape desired and is not used as a lining metal because it requires too great a heat to pour. It machines nicely and takes a fine polish on bearing surfaces. It has the appearance of aluminum when finished. Use a lubricating oil made from any good grade of machine oil to which 3 parts of kerosene have been added. HERRMANN G. KROEGER.

Louisville, Ky.

134. FOR ETCHING ON HARDENED STEEL.

First heat an iron or an old pillar file with a smooth side, and with it spread a thin, even coat of beeswax over the brightened surface to be etched. With a sharp lead pencil (which is very much preferable to a scriber) write or mark as wanted through the wax so as to be sure to strike the steel surface. Then daub on with a stick some etching acid made as follows: 3 parts nitric acid; 1 part muriatic acid. If a lead pencil has been used the acid will begin to bubble immediately. Two or three minutes of the bubbling or foaming will be sufficient for marking, then soak up the acid with a small piece of blotting paper and remove the beeswax with a piece of waste wet with benzine, and if the piece be small enough dip it into a saturated solution of sal soda, or if the piece be large swab over it with a piece of waste. This neutralizes the remaining acid and prevents rusting, which oil will not do.

If it is desired to coat the piece with beeswax without heating it, dissolve pure beeswax in benzine until of the consistency of thick cream and pour on to the steel and even spread it by rocking or blowing, and lay aside for it to harden; then use the lead pencil, etc., as before. This method will take longer. Keep work from near the fire or an open flame.

A. S. GUN.

* * *

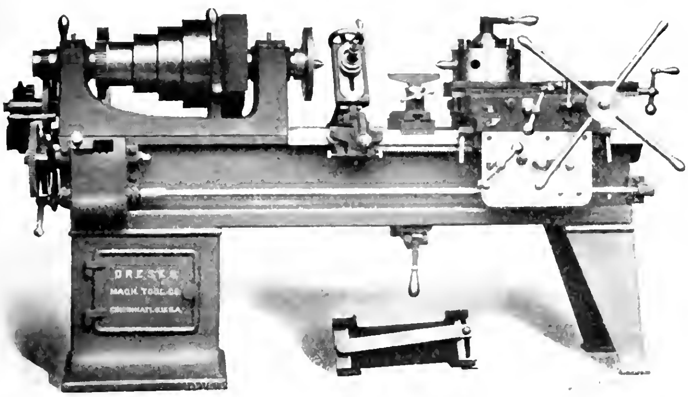
A waste product is something that is thrown away as having no economic value, but there is little that is absolute waste, even the chips produced in the machine shop being worked over into new iron and steel. There is one modern machining process that produces a shaving that has more value than that of mere scrap, and that is drilling rifle barrels with the oil-tube drill. The cutting edge of this drill is broken up into steps and the chips produced are literally shavings, being long hair-like threads of steel. These shavings are considerably used in woodworking factories for smoothing purposes.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

DRESES UNIVERSAL MONITOR LATHE.

This machine is designed for general brass and other similar work of special and heavy character, with the idea of doing away so far as is possible with the costly special tools necessary in the ordinary monitor lathe. The carriage on which the turret is mounted has a feed similar to that on the ordinary engine lathe, which is independent of the feed of the tur-



The Dreses Universal Monitor Lathe.

ret slide itself. This feed is through a pinion and the usual rack, fastened to the under side of the flange at the top of the bed. Since this rack is cut to an even circumferential pitch it may be used in combination with change gearing at the end of the headstock to lead taps and dies for cutting pipe threads, etc. The four feeds obtained by this means are increased to twelve by the interposition of change gears; the reverse is made by a knob in the front of the apron.

The turret slide does not bear directly on the carriage, but instead is mounted on a secondary dovetailed plate which may be connected to the taper attachment shown on the floor below the bed. The frame of this taper attachment slides between the V's, and the bolt which clamps the guiding bar also serves to hold it in any desired position longitudinally. This attachment may be removed instantly when it is not in use. The turret slide bed may be fed across the dove-tailed plate by crankhandle shown in the cut if a hand cross feed is desired. Screw clamping stops are provided for setting the turret holes exactly in line with the spindle. The combination of positive lead through change gears, and taper turning by means of the taper attachment and dove-tailed slide, makes it possible to cut internal and external pipe threads of any diameter without the use of taps and dies. The turret carriage is provided with pilot wheel and screw feeds. The turret revolves on a stem which is adjustable for wear and the locking pin withdraws at the return movement of the top slide, thus making the action semi-automatic. The machine is provided with a chasing attachment of which the follower is made yielding for taper work. Right and left-hand threads may be cut without changing the leader. The head stock is friction back-geared and has a four-step cone, provided with ample belt contact. The spindle has a 1 13/16 inch hole and is arranged to be used with a wire-feed attachment if desired. The cabinet support under the head is provided with tool shelves and the tail-end leg is attached by a pivot to form a three-point support. The complete machine weighs about 2,900 pounds and is built by the Dreses Machine Tool Co., Cincinnati, Ohio.

NEW BICKFORD RADIAL DRILL.

This machine is the latest product of the Bickford Drill & Tool Co., of Cincinnati, Ohio. Its capacity for drilling from the solid is rated at 2 inches diameter for steel and 2½ inches diameter for cast iron. It is of new design throughout and contains a number of modifications over its predecessors, but its chief characteristic is the arrangement of the speed box which, without back gears or a clutch of any kind, give instantly with a single lever six changes of speed.

Referring to Fig. 2, which shows the arrangement of the driving gears, C is driven at constant speed by a belt as shown in the cut or by a direct-connected motor if so desired. On O is made fast pinion D which, through the intermediate F, drives the large gear, M. This gear revolves loosely on the shaft L, but is connected by a ratchet with a collar on this shaft, so that if there is no other connection, shaft L will be driven from shaft C through these gears. As shown in the cut, there is besides, however, a sliding pinion, B, keyed to shaft C which, with the intermediate E, may be shifted along to engage with any one of the five gears G, H, I, J, and K. Referring to Fig. 1, which shows a front view of the machine, when the handle is in the extreme right-hand notch of the speed box, gear E will be between K and M. As soon as

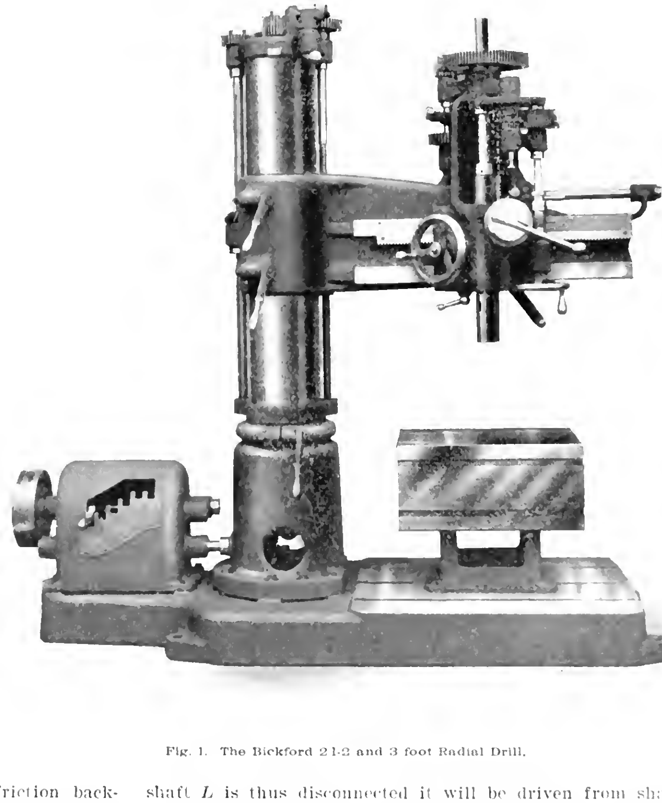


Fig. 1. The Bickford 2 1-2 and 3 foot Radial Drill.

shaft L is thus disconnected it will be driven from shaft C through D, F and M. If, however, the handle be moved one notch to the left, the drive will be through B, E and K, thus revolving shaft L at a greater rate of speed than gear M, a condition freely allowed by the ratchet connection between them. In

the same way the handle may be given any one of the four remaining positions, making possible six changes of speed in the feed box. The purpose of using a ratchet drive for the slowest speed is to allow gear E to be thrown into mesh with any one of its five mating gears while the machine is running. As the minimum peripheral speed of the smallest driven gear, G, is only 182 feet less than the peripheral speed of driving gear B, the shock which usually accompanies engaging gears broadside is reduced to a minimum, such shock as there is being absorbed by the belt.

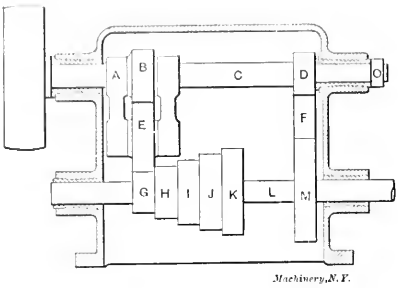


Fig. 2. Arrangement of Gearing in Speed Box.

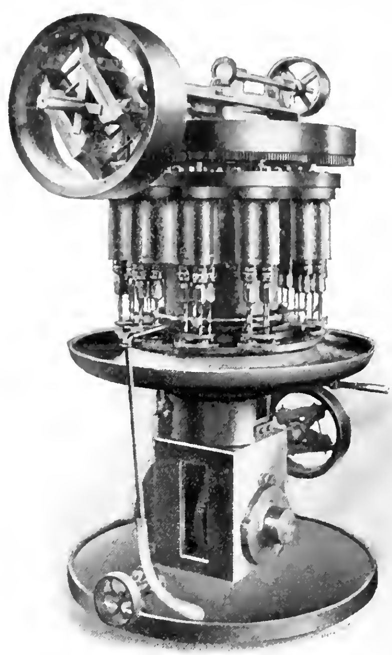
A plate in front of the gear box shows the position the lever should take to give the proper speed for the diameter of drill which is in use at the time. The upper row of figures relates to the direct drive and the lower row to the back-gear drive, the back gears being located on the spindle head. The range of the twelve changes of speed thus possible is shown in the following table:

No. of Revs. per min. made by Spindle.	Diam. of Drills for which Speeds are Suitable.	No. of feet per min. at which Drilling is done.	No. of feet per min. at which Drilling should be done.
265.09	1/2	34.60	35.0
209.86	5/8	34.34	34.3
173.68	3/4	34.10	33.6
143.91	7/8	33.07	32.9
122.84	1	32.16	32.2
104.29	1 1/8	30.72	31.5
95.41	1 1/4	31.22	30.8
75.53	1 1/2	29.66	29.4
62.51	1 3/4	28.74	28.0
51.79	2	27.12	26.6
44.21	2 1/4	26.04	25.2
37.56	2 1/2	24.56	23.8

A comparison of the figures in the third and fourth columns indicates that the makers have been careful in the selection of gears, as in no instance does the cutting speed vary from the theoretically correct condition by more than 0.84 of a foot per minute. Another noticeable point is the irregular gradation of the speeds. The usual geometric progression is purposely departed from in this machine and instead, the various sizes of drills, as shown by the plate on the speed box, are each given their proper surface speed irrespective of the relation which these different speeds bear to each other. The makers claim that this gives practically a more useful range than does the true geometric progression which will give rates of speed varying from 2 to 9 per cent greater or smaller than they should be for the commonly used diameters. The machine is also furnished with a five-step cone drive, a constant or variable-speed motor drive, a swinging or swiveling table, and a round or double end base.

THIRTY-SIX SPINDLE AUTOMATIC DRILL.

The half-tone shows a multiple-spindle drill built by the Moline Tool Co., Moline, Ill. The work table is an annular ring which may be indexed to ten different positions and is intended to carry, clamped to it, ten work-holding jigs. The drill head is spaced to carry ten separate groups of drill spindles, four spindles in each, but one of the groups is omitted so as to allow a position in front of the operator where the work can be removed and inserted. This gives a total of thirty-six spindles to the machine. Each separate drill is vertically adjustable to allow for different lengths of drill and heights of work, and the table is vertically adjustable in addition to the movement given by the feed mechanism. The feed is operated by the cam shown in the base, the table and work-carrying ring moving up toward the drill spindles, as the feed-



A Multiple-spindle Automatic Drill.

ing progresses. The feed and the indexing and locking of the ring are all automatic, so the workman has nothing to do but keep the machine supplied with work. A rotary oil pump and tank for lubricant is provided.

DIRECT-CONNECTED ENGINE AND FAN FOR HANDLING HOT GASES.

In designing fans for induced draft plants for boilers there is considerable difficulty in supporting the shaft in such a way that it shall be rigid and at the same time have its jour-

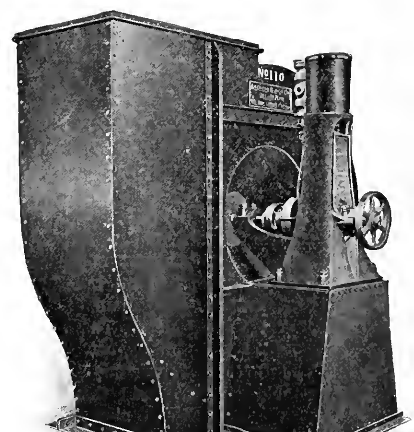


Fig. 1. Improved Arrangement of Engine and Fan Housing.

nals located where the heat of the furnace gases will not affect the bearings. It is impossible to support the shaft by outboard bearings at the inlet side of the housing on account of the fact that this would be in the direct path of the hot gas.

The American Blower Co., of Detroit, Mich., is using a construction which obviates the difficulty and makes a very satisfactory construction in other respects as well. Fig. 1 shows a fan directly connected to a vertical high-speed engine. The shaft is supported by bearings, three in number, in the engine frame, all of them made in one casting and bored out at the same time. This means that they are permanently in alignment and do not require to be journaled in self-adjusting boxes. The blades of the fan itself, instead of being supported by a double or triple spider as is usually the case in units as large as this one, are mounted on a single central spider whose arms, made of rolled steel, are cast into the iron hub. The blades are braced to each other and to the arms in such a way as to make an exceedingly rigid construction. This use of a single central spider allows the outboard bearing of the engine to be placed much nearer the center line of the fan than would otherwise be the case. As may be seen in the half-tone, the fan housing is recessed to allow this to be done. Another advantage of making the three bearings in the engine frame instead of mounting the third one on the housing as is sometimes done, is that all strain is thus removed from the sheet metal casing, which may thus be of considerable lighter construction than would otherwise be necessary.

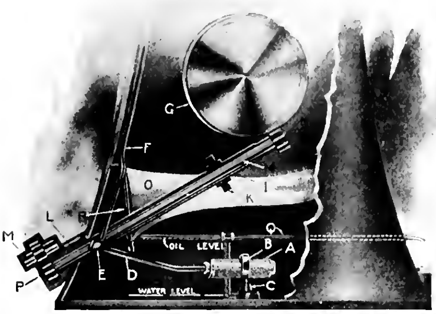


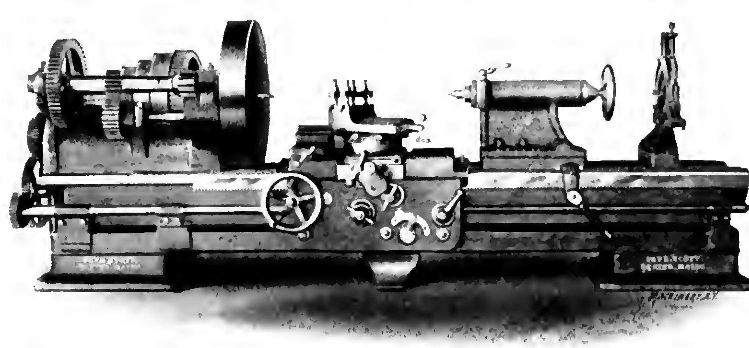
Fig. 2. Oiling Device for Engine.

The engine is of the enclosed type with all of the bearings oiled by the positively driven pump shown in Fig. 2. *G* is a worm of large diameter mounted on the crankshaft and driving the small worm wheel, *N*, which in turn drives the two gears *P* and *M* of a rotary geared pump. This pump gets its supply of oil from a reservoir in the base and forces it through pipe *F* to the various journals, bearings, etc., even lubricating the eccentric outside of the frame. Tests in actual practice have proven that it will run several months without oiling or adjustment.

FAY & SCOTT THIRTY-EIGHT INCH ENGINE LATHE.

This new machine has recently been added to the line of lathes built by Fay & Scott, of Dexter, Maine. The spindle is driven by triple gearing and is made of high-carbon steel with accurately ground journals. The bearings are made of bronze, scraped and fitted. The carriage slides on longitudinal V ways, carries a compound rest, an auxiliary wing rest, and is securely gibbed to the bed. The apron is tongued and grooved into the carriage, and all gears and studs are particularly heavy. The tailstock is of the cut-away type.

The ratio of the back gearing is 12 to 1 and of the triple gearing 40 to 1. There are five steps to the cone, varying from 8 to 22 inches in diameter for a 4-inch belt. The hole through the spindle is 3 1/16 inches in diameter. The front journal is 6¼ inches in diameter by 10½ inches long, and the back one is 4½ inches diameter by 7 inches long. The machine swings 24 inches over the carriage and weighs 14,500 pounds with a ten-foot bed.



Fay & Scott Thirty-eight inch Lathe

THE RANSOM MOTOR-DRIVEN DRY GRINDER.

This machine is one of a line built by the Ransom Manufacturing Co., Oshkosh, Wis. It will take a wheel 12 inches in diameter by 2 inches wide. The line includes four sizes, of which the largest will take a 30-inch wheel 4 inches wide. The emery wheels are mounted on the extended armature shaft which is made of high carbon steel of large diameter, turned and ground. The journals are ring oiling and run in dust-proof phosphor bronze boxes. In the arrangement shown in the cut, the machine is mounted on a heavy sub-base with floor area large enough to insure steady running. In the cupboard in this base are mounted a starting box, switch, and non-arcing fuses. The grinding rests are supported by heavy cast-iron shields which encircle the wheels, leaving open only the space where the grinding is done. The machine runs at 1,700 revolutions per minute.

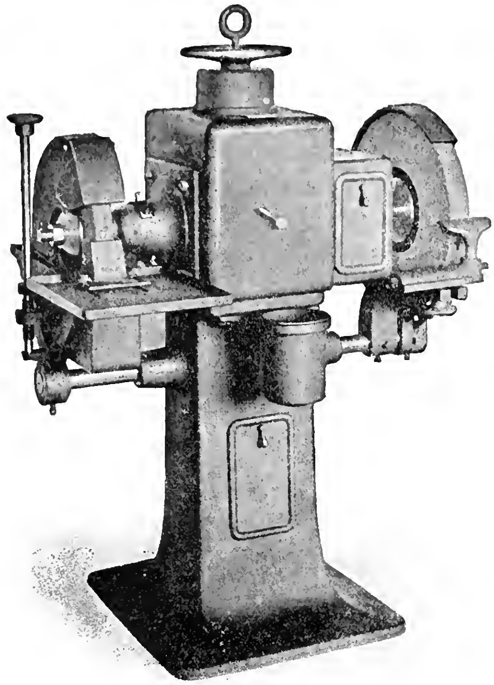
Ransom Motor-driven Grinder.

THE STOW ELECTRIC EMERY GRINDER.

This machine, as shown in the accompanying half-tone, is a combination wet and dry grinder driven by the well-known Stow variable-speed motor. The wet wheel mounted on the left side of the motor is properly encased and the water tank below the wheel may be elevated to any desired height by a turn of the vertical rod shown on the extreme left. The level of the water is then raised into contact with the wheel and a more even distribution is possible than with the older foot-pedal arrangement. Both wheels are provided with convenient adjustable grinding rests. A cast-iron water pot is located between the wheels.

The use of the Stow type of motor allows the operator to

obtain exactly the speed required for his work to give the best results. The change is made by infinitely small gradations and not, as is the case when a rheostat is used, by comparatively long steps. The motor is started and stopped by turning the short lever on the front of the frame to the right or left. Speed variation is secured by turning the hand wheel on top of the motor. The base is large and the running parts carefully balanced to reduce the vibration as much as possible. The machine shown is adapted for wheels not exceeding 2 x 18 inches in diameter. The Stow Manufacturing Co., Binghamton, N. Y., are the builders.

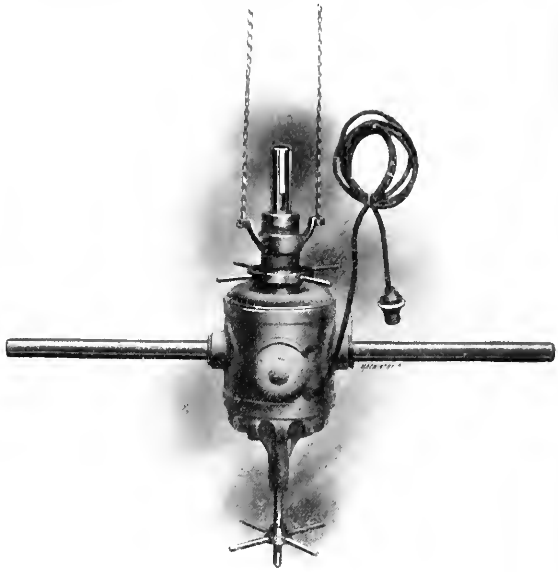


Variable Speed Motor-driven Grinder.

TWO NEW ELECTRICALLY-DRIVEN TOOLS.

The electric drill and grinder shown herewith are examples of a line manufactured by the United States Electric Tool Co., of Cincinnati, Ohio. These tools may be carried by a workman from place to place wherever his work takes him, and on being attached to a lamp socket, they will serve to drill or grind anything within the limits of the tool's capacity; for the drill, this capacity ranges from ¼ inch up to and including 1¾ inch in diameter, depending on the size. The tool illustrated has power enough to handle a 1¼-inch drill. It is 22 inches high, 7½ inches wide, and each handle is 14 inches long. The tool is provided with screw and chain feed. In case the latter arrangement is used, a chain is passed around the work and its two ends fastened to the yoke which is mounted on the spindle sleeve. The feed is obtained by a threaded nut, which draws the whole mechanism forward through the yoke. A common drawback in using electrically-driven drills is that when the point of the drill is about to break through the hole it is liable to fracture, due to the increase of speed and irregularity of the cut. This bad feature is overcome by the builders of this line by equipping each of the different sizes with a variable-speed control which gives four different rates of speed to the spindle; when the drill is on the verge of breaking through the material, the speed may be lowered instantly, thus saving the tool. This arrangement also provides for working with different diameters in different materials.

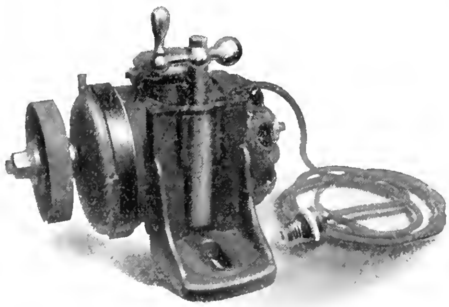
The grinder shown should find extensive use throughout the machine shop. It can be applied easily to a lathe, milling machine or planer, it can be run independently on the bench, or it may be used as a portable tool for cleaning castings in the foundry or shop. A feature of both the drill and grinder motors is that they are built up of thin layers of steel, both in the case of the armature and the field, thus making the motor more efficient and powerful than if they were made of cast or wrought iron. These electrically-driven tools serve as well for a number of miscellaneous uses, such as, for instance, drilling and tapping staybolt holes in boiler shops; one of the latest developments is their use as flue expanders, when provided with suitable attachments.



Electrically-driven Drill.

THREE-HOLE CLEVELAND AUTOMATIC SCREW MACHINE

This machine resembles in its design and appearance the regular line of automatic turret machines made by its builders, the Cleveland Automatic Machine Co., Cleveland, O. It is designed for making parts from bar or magazine which can not be handled on the plain machine, and which do not require enough operations to make the use of the regular turret machine advisable The turret, which is made to hold three tools, has holes 1½ inch in diameter. On the regular 1¼-inch turret machine they are only 1¼ inch in diameter and this enlargement allows the use of large hollow shanks for the milling tools, die holders, etc., thus making it possible to take longer cuts of larger diameter than can be handled by the regular line of machines.



Portable Electrically-driven Grinder.

The machine consists essentially of a spindle driven by a shifting belt to allow reversal for thread cutting, and provided with means for feeding and holding a bar of stock; a longitudinally placed drum turret provided with mechanism for indexing and locking it; and a cam shaft at the rear of the machine which governs all its functions and may be given a

slow motion for feeding or a rapid motion for the idle movements. The spindle mechanism is similar to that on the regular Cleveland automatic screw machine. The belt is shifted for reversal by a quick-acting mechanism governed by dogs on the cam shaft. Other cams on the same shaft open and close the chuck and feed the stock. The feed cam is longitudinally adjustable to vary the length of stock presented to the action of the tools. The head stock, when necessary, may be provided with the three-speed attachment which is furnished with the regular machine. The cam shaft at the rear of the machine is driven by a belt from the countershaft through pulleys *G* or *D*, the change gears, and a worm and worm wheel. A series of dogs, *C*, is adjustably clamped around the periphery of the worm wheel, in position to engage the free end of a belt-shifting lever. Inside of pulleys *G* and *D* is situated a differential gear train which gives either a rapid or a slow movement to the mechanism, depending on which pulley the belt is driving. By suitably disposing the dogs, *C*, the cam shaft may then be given a fast or slow motion at predetermined points to suit the work that it has to do.

The cross slide is governed by cams in the same way as on the regular machine and will take the same tool post, tools and magazine attachments that the regular machine does. It is regularly built to use a single tool, but can be made to use a front and back tool if desired.

The mechanism for rotating and locking the turret is new with this machine. Around the inner edges of the drum *H* are adjustably clamped dogs, *A*, on each of which are formed two cam surfaces. One of these, by suitably connecting levers, withdraws the locking wedge which prevents the turret from rotating. The other one acts on the free end of toothed segment *B*, which may be seen in the end view. This segment meshes with a sleeve at *E* on the turret spindle, this sleeve being connected to the spindle by a pawl and ratchet. As the cam *A* forces the segment over, after unlocking the turret, sleeve *E* is revolved and the ratchet carries the turret with it for a third of a revolution. When this movement has been completed the locking wedge is dropped into place and the turret may then be fed up to the work. Arm *B* thereupon again returns to its normal position, the pawl slipping back over the ratchet ready to engage it again the next time it is necessary to index the turret. From the fact that both the indexing and the locking mechanisms are controlled from cam surfaces integral with each other, it is impossible for any one to carelessly set the indexing mechanism to operate before the turret is unlocked or derange the order of operation in any other way. There are three cams *A*, which may be arranged in any position so as to index the turret whenever it is necessary to do so.

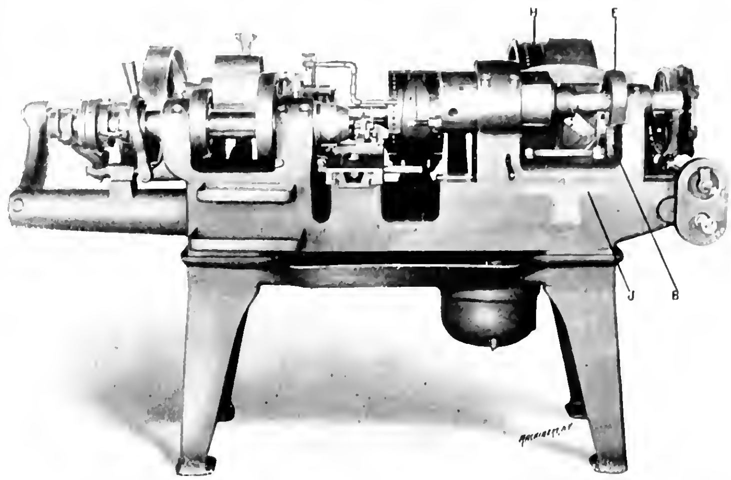


Fig. 1. The Cleveland Three-hole Turret Machine.

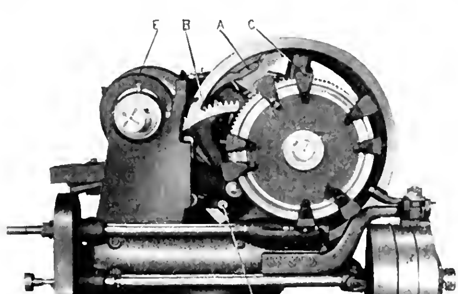


Fig. 2. End View of Three-hole Turret Machine.

On the drum *H* is mounted a series of cams for feeding the turret. Two sets of these cams are provided, these, in conjunction with the fast and slow motion for the cam shaft, being sufficient to cover the usual run of work. The advantage of this fast and slow movement is readily apparent. Full control of the feeding is given with no loss of time. That is to say, the cam may advance the turret the full stroke of seven inches or may advance it a length of only one-half inch, as the case may be. If the latter condition is desired, the turret is fed forward rapidly for the first 6½ inches, when the belt is shifted onto the slow pulley and fed slowly for the remaining half inch. If it is desired to take two strokes of the turret tools, each of them only one-half inch long, the turret may be arranged to recede just far enough to clear the end of the stock without carrying it back the full stroke. The machine is then indexed and the next feeding cam rapidly brought into position for its second half-inch feeding stroke. The turret can also be held in the rear position for all operations, thorough control of the turret being given for either long or short strokes.

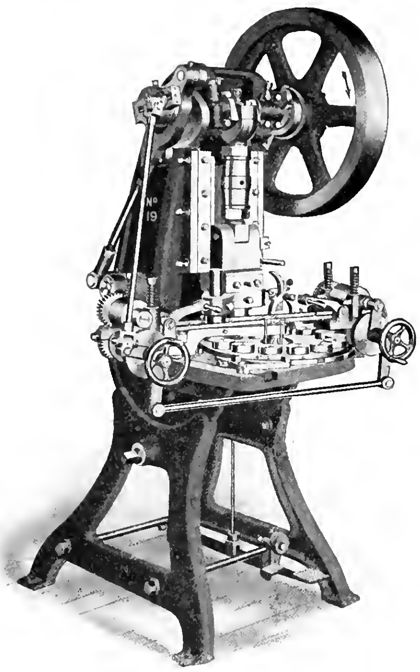
The head may be adjusted forward and back for a distance of nine inches. It not only carries with it the turret, but the drum *H* on the cam shaft as well, and the entire turret-feeding and indexing mechanism. Drum *H*, though splined to the cam shaft, is free for this purpose, to move longitudinally. This adjustment provides means for operating on various lengths of stock. On the front of the machine in Fig. 1 is shown a scale, fastened to the bed, and above it a pointer on the head. The pointer and scale may be used to duplicate the setting of the head for any given piece whenever it is desired to do a job the second time, since if the original setting is noted and a record kept, the machine may again be set to the same identical position. This arrangement materially lessens the time required to set the machine up for doing work which has been done before.

By using bushings to enlarge the diameter of the shanks of the various turret tools, those furnished for the regular machine may be used. Such attachments as magazines, third spindle speed, high-speed drilling mechanism, etc., may be provided. The builders have found that this design fulfills the requirements of a large range of the work that an automatic screw machine is required to do. It is built to handle either 1¼-inch or 1½-inch stock, and will take a cut 7 inches long.

"BLISS" PRESS WITH SPECIAL COMBINATION FEED.

The machine shown in the accompanying half-tone is a regular "Bliss" Inclinable Power Press fitted with a special combination feed consisting of a double roll feed, an automatic dial feed and an automatic pickoff. The roll feed takes the material to be operated upon from the reel, and blanks or forms the first operation of the piece to be produced, dropping same into one of the pockets of the dial as it revolves. The dial feed carries the piece under the second punch where it is further operated upon. In some cases it is possible to have a third and even a fourth die, the dial feed carrying the piece successively under the several punches. The second set of feed rolls is used for keeping proper tension on the stock and also for carrying away the scrap.

As illustrated, the press is fitted to take heavy paper from the rolls and feed it over a cover which has been previously drawn in a combination die. The first punch cuts out a paper disk which is dropped into a recess in the cover—the cover being on the dial which passes under the blanking die. The



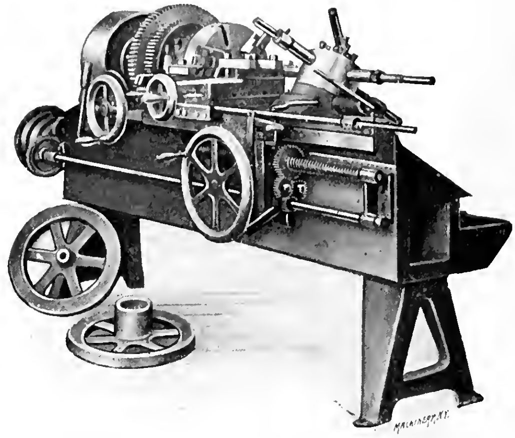
Bliss Press with Special Feed.

second punch closes down the edge of the recess, thus holding the paper tight. The nature of the work is such that it is impossible for the finished article to fall through the pockets of the die, and in order to rapidly remove the work an automatic pickoff is employed. This consists of two fingers which are operated by a small arm on the slide. At every stroke of the press the gripping fingers close about the article and automatically eject it. All that is required for the operator is to keep the pockets of the dial full of the covers. This is done rapidly and without any danger to the operator's fingers, inasmuch as his hands need never be near any of the dies.

The feed is of a type which has a wide range of usefulness, and with modifications may be fitted to almost any type of press. This press was built by the E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y.

THE MOLINE TOOL COMPANY'S TURRET LATHE.

This machine, of which one form only of a number of alternative arrangements is shown in the accompanying half-tone, has been designed by its builders, the Moline Tool Co., Moline, Ill., for handling castings and bar work. The illustration shows it fitted with tools for machining small gasoline engines or automobile flywheels. The carriage has a turret for boring operations and two cross slides, one of which carries the tools for turning and facing the rim of the flywheel, while the other machines the pulley which in some cases is cast solid with the wheel. This second slide rest has a forming attachment for crowning the pulleys. The feed for this carriage is actuated by a nut which travels on a stationary screw of coarse pitch; the nut is long and the screw may be turned end for end in case one side of the thread gets badly worn, thus making a durable feeding mechanism. The nut is driven from the feed rod through tumbler gears and one lever controls the starting, stopping, and reversing. The bed, as may be seen in



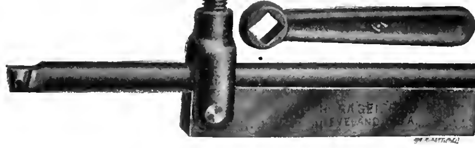
Moline Tool Company's Turret Lathe.

the illustration, is made of hollow box form with its top inclined so that the chips slide off into the pan at the rear. The carriage has a long bearing on the rectangular way at the front and on the surface at the top of the bed. The cross slide is supported at the rear by two flat ways, the upper one extending out below the lower one so that the chips do not fall upon the bearing parts at all.

The spindle is 6 inches in diameter and has through it a $3\frac{3}{4}$-inch hole. In the arrangement shown, three speeds only are provided, one direct and two back geared, all of them secured by the lever at the right of the headstock. This headstock is cast solid with the bed. The driving pulley is 16 inches in diameter and wide enough for a 6-inch belt, and the lowest back gear ratio is 12 to 1. This head, however, is a special arrangement, the regular design providing for eight changes of speed or, with a double-speed countershaft, sixteen changes arranged in geometrical progression. An alternative arrangement also provides for a change-gear box in place of the cone pulleys shown.

THE GEIER BORING TOOL HOLDER.

This holder is adapted to make use of tools with a cutting lip forged from round unannealed stock. The tool may be extended from the holder just enough to reach the bottom of the hole it is desired to bore, thus giving the cutting edge all the support possible, and at the same time furnishing a con-



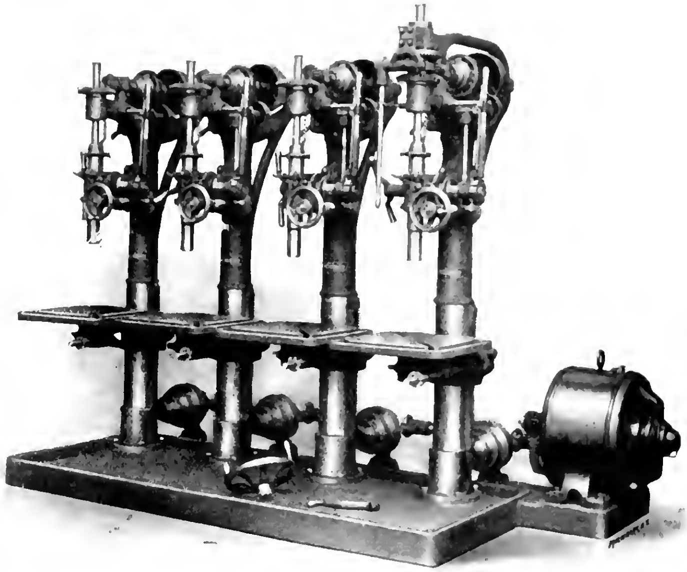
Geier Boring Tool Holder.

venient gage for the depth. The clamping of the holder in the tool post serves also to clamp the tool more firmly in the holder. The shank is milled from bar steel and case-hardened, and will fit any tool post with a 9-16 x 1-inch slot or larger. The yoke is drop forged of steel and has a hardened steel setscrew A drop-forged wrench is packed with each tool. This holder is made by the P. A. Geier Co., Cleveland, Ohio.

CINCINNATI HEAVY PATTERN GANG DRILL.

The cut shown herewith illustrates a special arrangement of 21-inch drills, built by the Cincinnati Machine Tool Co., of Cincinnati, Ohio. As shown, four of their heavy pattern drills of this size are arranged in a row and driven by a constant-speed motor at the right-hand end. The regular tight and loose pulleys on the machines have been discarded and a bevel gear drive substituted in place thereof. The first machine in the row is fitted with a positive-geared tapping attachment, but otherwise the four are alike in design, having wheel and lever feed, back gears, quick return to the spindle and power feed. The raising and lowering device for the tables is necessarily different from the standard form in that it is operated from the front. Square, oil-grooved tables will be furnished in place of the usual round ones unless otherwise ordered, since it is designed to use a pump and suitable piping for conveying a lubricant to the drills, returning it again to a tank for use over again.

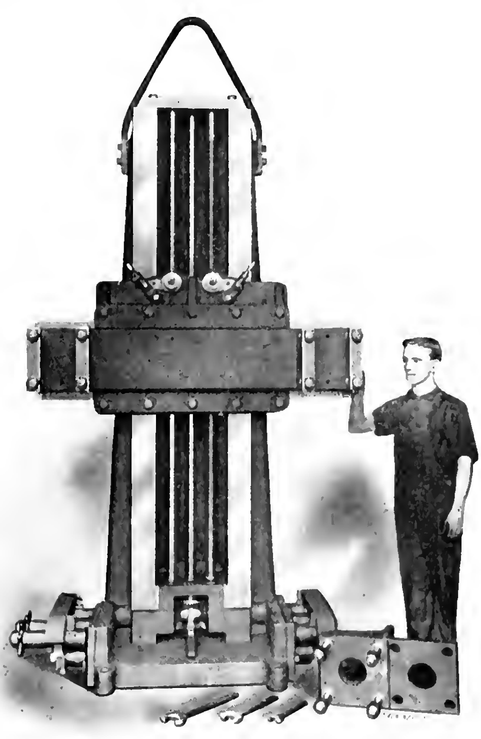
The arrangement shown can be modified to suit any conditions required by the purchaser. The drills may be furnished with or without tapping attachment, with or without back gear, with or without power feed, or with one continuous table instead of square or round tables. Any other form of drive than that shown will also be provided by the makers if so desired.



Cincinnati Motor-driven Gang Drill.

PORTABLE TOOL POST.

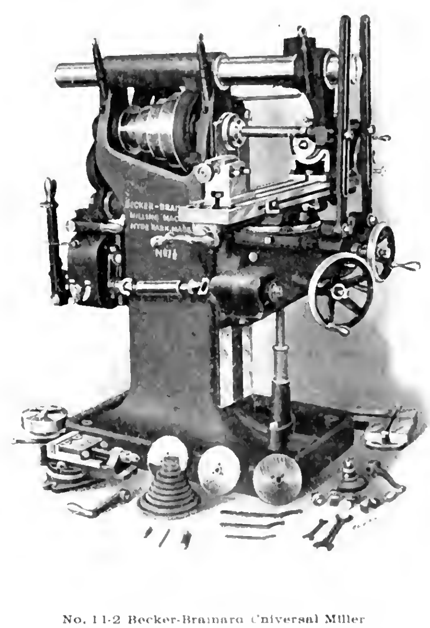
In connection with the Crocker-Wheeler boring mill which was illustrated in the November issue, we mentioned a portable tool post built by the Espen-Lucas Machine Works, Philadelphia, Pa. This tool, in a modified form as shown in the cut, can now be furnished by the builders for a number of uses which will readily suggest themselves. It may be used as a tool post for a boring mill of the type before mentioned, or it can be used as a stationary tool post for working on the outside of castings in the ordinary type of boring mill. In the arrangement shown, the feed for the head and ram is obtained through star wheels at the base. The machine is very strongly built for doing heavy work, steel castings being used throughout to give the required stiffness for the work it is designed to do.



Espen-Lucas Portable Tool Post

THE BECKER-BRAINARD UNIVERSAL MILLING MACHINE NO. 1 1-2.

The machine shown in the cut has been put on the market to fill a demand for a machine heavily and strongly built, having a capacity midway between the regular No. 1 and No. 2



No. 1 1-2 Becker-Brainard Universal Miller

machines. This size will take a cut 21 inches long, has an 8-inch cross feed, and a 17-inch vertical movement. The spindle is of hammered crucible steel with a 3/4-inch hole throughout its length and a No. 10 B. & S. taper in the front end. It is threaded to take a chuck, and slotted across the end to engage the clutch collars on the cutter arbors. The spindle

is provided with protected back gears. The knee is of the box type, provided with telescopic elevating screw. The elevating and cross-feed hand wheels are provided with a clutch arrangement which allows these wheels to turn freely when not in use, thus preventing an accidental change in the adjustment. Adjustable dials are provided for all the movements graduated to read to .001 inch. The feed change mechanism will give instantly without stopping the machine twenty changes of feed, by a simple movement of the lever.

The machine being full universal, the table is centrally driven and feeds freely at any angle up to 45 degrees right or left hand. The dividing head can be set at any angle from 10 degrees below the horizontal to 5 degrees beyond the perpendicular. The front end of the spindle of the dividing head is identical with the machine spindle so far as its taper and its thread are concerned. A raising block is provided which allows the head to be set at any angle for taper work. The head is arranged for plain and differential indexing for all numbers up to 360. The change gears provided give a range of spiral cutting from 1.25 to 68.57 inches pitch for one turn. The machine is built by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

LANDIS CRANK GRINDER.

The illustrations in this connection show a crank grinding machine for grinding single and multiple crank shafts for automobile engines, launch engines, etc. The machine has recently been placed on the market by the Landis Tool Company, Waynesboro, Pa., and as now made is fitted with adjustable heads of an entirely new design so that the several crank pins may be accurately and quickly located in their correct relative positions for grinding. The head and foot stocks are geared together, their spindles being driven by a splined shaft upon which slide the pinions which transmit power to the spindles. The adjustable offset heads for carrying the work when grinding the crankpins hold the cranks by end journals and when in use are attached to the faceplate of the machine. These heads are arranged with two independent rotary adjustments. One of these adjustments is for locating the crankshaft so as to give the correct throw to the cranks and the other consists in an adjustment for the clamp which grasps the work and is for obtaining the different relative crank positions. For example, if the cranks are spaced 120 degrees or 180 degrees apart, the second adjustment would be used to locate the different pins at these angles.

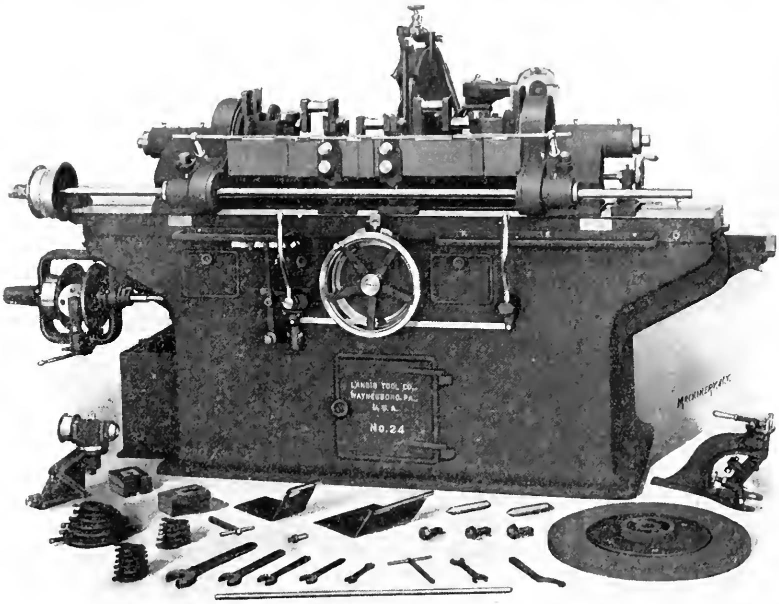


Fig. 1. Landis Grinder arranged to Finish Automobile Crankshafts.

In Fig. 2 is a cross section and a front view of one of the adjustable heads. In the front view, the circle of largest diameter represents the periphery of the face plate, and the slot in the upper part of the plate is for attaching the counterweights. The disk D which is mounted eccentrically upon the faceplate and is held to it by bolts in a circular T-slot, may

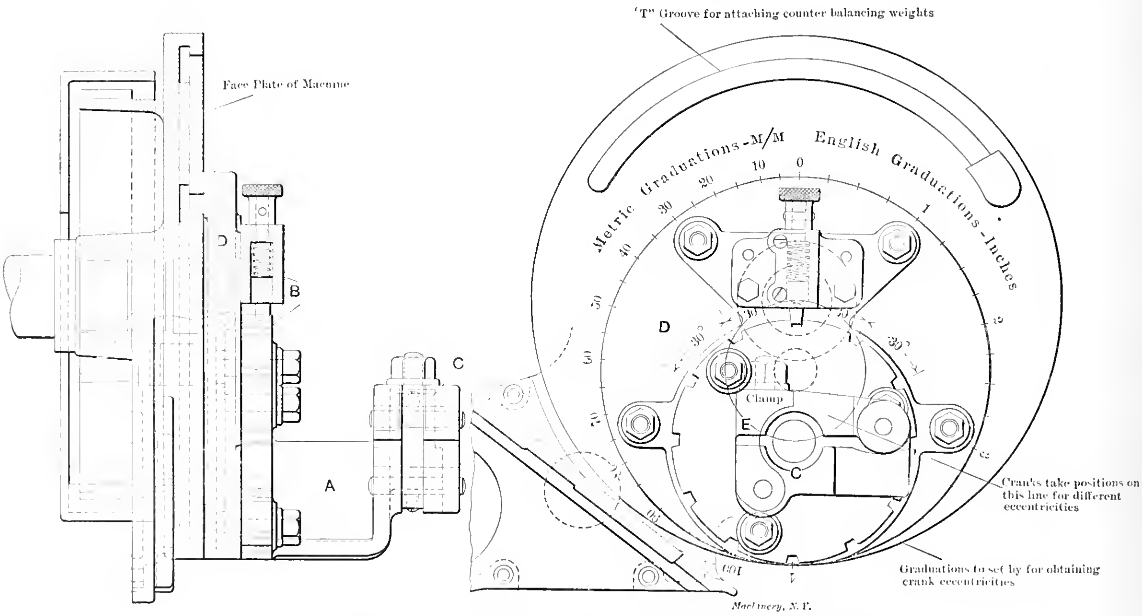


Fig. 2. Special Chuck for Holding Crankshafts having up to four inches Eccentricity.

be swiveled to give the desired throw or eccentricity to the crank. The clamp *C* which grips the work is attached to a smaller disk, *E*, which, with the stop pin used to locate this plate at the proper angle, is carried by a base or spider, bolted to the disk *D*. This smaller disk *E* which carries the clamp, is eccentric with the large disk *D*. Graduations on the periphery

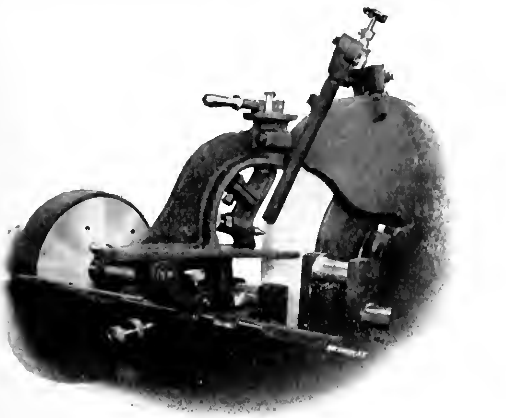


Fig. 3. Wheel Truing Device in Operation.

of the large disk are made both in English and metric units and in swiveling it, the center of the shaft follows the circle *E* until it reaches a point which is the correct radial distance from the center of the faceplate of the grinder, when the disk *D* is clamped, holding it permanently in this position. The other adjustment, by which the small disk *E* and the clamp which it carries is rotated to the proper crank angle, is effected by the stop pin *D* fitting in notches in the edge of the disk.

In Fig. 3 is shown the emery wheel truing fixture in place for use, attached to the top of the stationary back rest. The lever on top is for swiveling the diamond holder when rounding the corners of the wheel for grinding fillets.

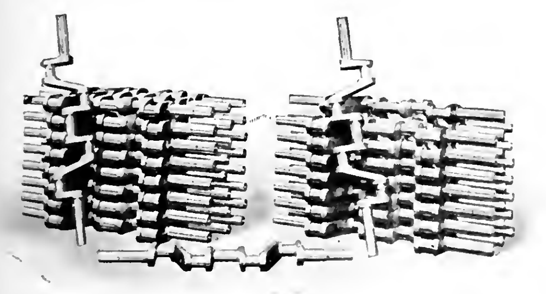


Fig. 4. A Pile of Fifty Finished Crankshafts.

Fig. 4 shows some of the products of the machine, this representing fifty automobile crank shafts. The parts to be ground are the four crank or wrist pins, 1¾ inch diameter by 3½ inches long; three journals 1¾ inches diameter by 3½, 4½ and 6½ inches long respectively. In grinding 1/32 of an inch was removed from the diameter and the average time for each crank was two hours.

PEDRICK & SMITH PIPE-BENDING MACHINE.

The accompanying half-tone illustrates a machine for bending pipe, which has been recently perfected by Pedrick & Smith, Germantown, Philadelphia, Pa. With a machine of the size shown steel, iron, brass or copper pipe can be bent cold of any size up to and including two inches in diameter. By using special formers, light angles, flats and T-bars may also be handled. The power for the operation is furnished by a handwheel geared at a ratio of 25 to 1 with the faceplate to which the bending quadrants are attached. The pipe is held in the quadrant at one end by means of a steel plate while the resistance stud on the adjustable arm engages the other end. The various curvatures are obtained by adjusting the arm, which has a swing of three-quarters of a circle, supplemented by the movement of the resistance stud in the T-slot of the arm.

By means of the telescopic stand on which it is mounted the machine may be raised or lowered to any suitable height. With the base fastened to the height desired the upper part may be swiveled to any angle. For work that is awkward to handle in a vertical plane, a universal arm for the stand is provided which allows the faceplate to be placed in a horizontal position at any height from the floor. Quadrants are regularly furnished with the machine for 1-inch pipe with a

Pedrick & Smith Pipe-bending Machine.

radius of 6 inches, 1¼-inch pipe with a radius of 9 inches, 1½-inch pipe with a radius of 12 inches, and 2-inch pipe with a radius of 14 inches. While these four quadrants are provided, smaller sizes of pipe can be readily bent in the larger sized quadrants. From practice it has been found that workmen will not take the time to change the quadrant unless they desire a smaller radius than the larger quadrants will give them.

EBERHARDT BROS. SIXTEEN-INCH SHAPER.

The Eberhardt Bros. Machine Co., 66-68 Union St., Newark, N. J., have put on the market a 16-inch crank shaper which possesses a number of novel features. Perhaps the most noticeable innovation, looking at the machine face on, as it appears in Fig. 2, is the shape of the guiding surfaces of the ram. The ram is seated in vertical V-ways similar to the bearings of a planer table. The V-ram has the advantage of guiding the tool in a rectilinear position which tends to wear itself continuously in alignment, with the added advantage of an increased rigidity of ram and frame under severe side strains when taking a heavy cut with a side tool. With the frame of the shaper made as it usually is, open in the center to allow the insertion of shafts for key seating, the tendency is to spread apart the side-bearing surfaces of the ram, allowing a looseness which produces chattering of the tool and reduces the efficiency of the machine. With the construction shown, however, the two sides of the frame are tied together by the ram itself, the heavy strain of a roughing cut with the side tool being taken directly by broad, flat straps, the pressure being normal to these straps. The makers state that this arrangement has shown itself to be of decided value in increasing the capacity of the machine when taking cuts of any kind which tend to give a side pressure to the ram-bearing surface.

Another interesting feature is the fact that the stroke may be adjusted while running, and this adjustment may be made in accordance with graduations visible even when the machine

is running at the highest speed. Instead of the usual plan of having a scale on the moving ram read from a stationary pointer, the scale is mounted on a bracket projected from the boss which supports the bull wheel, as shown in the line drawing, Fig. 3, the pointer being replaced by a continuous circular graduation on a collar which moves in or out on the end of the shaft to correspond with the change in length of the stroke. The position of the ram with relation to the cross head may also be adjusted when the machine is running, if necessary, by means of a crank on the vertical squared shaft projecting from the top of the ram. The machine is furnished in the single-geared or back-geared design as desired by the purchaser. In the back-geared style a double train of gearing is used with a double bull wheel, as shown by the line cut. This feature, although not new, has not been generally adopted. It costs little more than the usual methods of back gearing, and has the advantage that the cutting power and cutting speeds may be conveniently adjusted to suit various grades of material and classes of work without the high rotating speeds of shafts and gears which are unavoidable in other designs when running on short strokes. The cone pulley runs on its own bearing and not upon the pinion shaft, thus relieving the shaft of all belt strain.

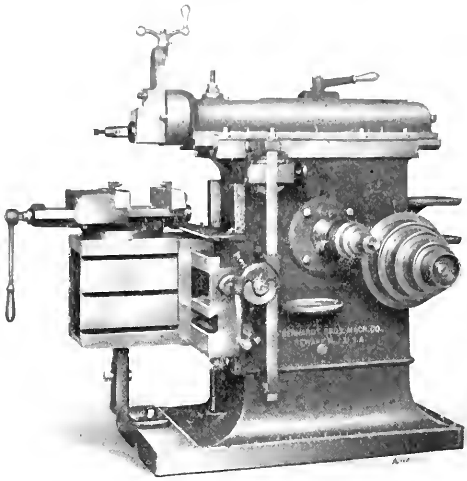


Fig. 1. Eberhardt Bros. Sixteen-inch Shaper.

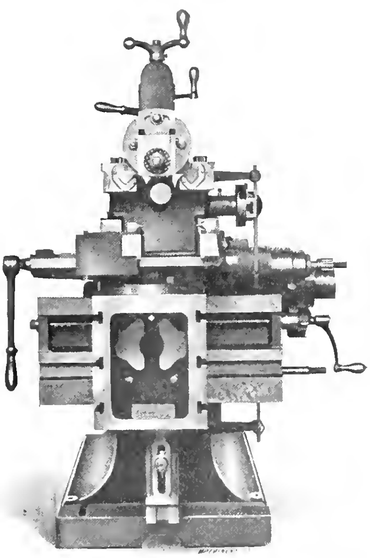


Fig. 2. Front View, showing Design of Ram Bearings.

The box table is of the universal type and may be swiveled in a circle; any side of the box may thus be used as a working side. The vise is graduated and may also be swiveled to any angle. The construction is such that the jaws are drawn together instead of being pushed, thus subjecting the screw to a compressive instead of a tensile strain. This has the advantage of holding the work more firmly without straining the body of the vise. The method of holding the vise to the table is such that all adjustments are made from the top. The feed is operated by the vertical reciprocating feed bar shown in Fig. 1. The connection with the cross-rail mechanism is through a friction strong enough to carry the heaviest feeds, yet light enough to offer little resistance to raising or lowering the table whenever necessary. The feed may be changed instantly when the machine is running or at rest. There are no rapidly oscillating or revolving parts to be adjusted, and the hand wheel used in the adjustment is so located that danger of injuring the fingers of the operator is avoided. The table is furnished with extension base and positive support, this support being conveniently adjustable. The foot is reversible to allow the support to be used when the table is raised or in the lowest position. The general design of the machine is intended to fit it for taking the heaviest cuts required for manufacturing, and at the same time give it the accuracy required for tool room work, with all the adjustments so arranged that they may be altered without loss of time while the machine is running. If desired, this shaper will be furnished without the back gears.

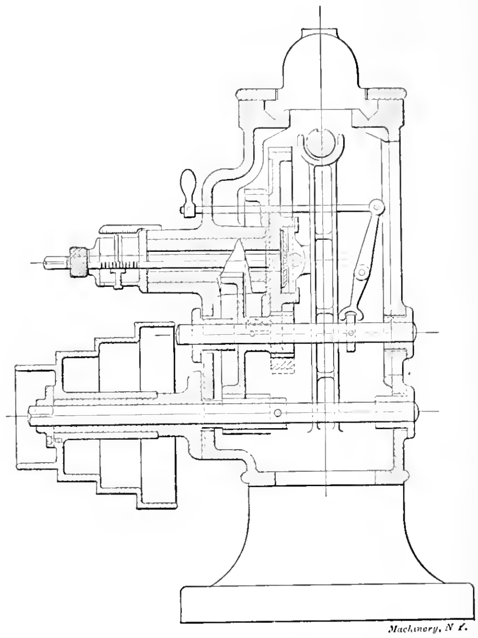


Fig. 3. Driving Mechanism of Eberhardt Bros. Shaper.

AUTOMATIC ROTARY SURFACE GRINDER.

The half-tone cut shows a surface or face-grinding machine of the vertical spindle type. The spindle of the machine is driven by a cone of pulleys with eight diameters giving spindle speeds suitable for any work within the range of the machine. A magnetic chuck is regularly furnished for holding the work, this affording the quickest way of fastening thin parts without the liability of springing them. A direct current of either 110 or 220 volts will operate this chuck satisfactorily, connection being made with an ordinary lamp socket. Alternating current cannot be used. In shops where direct current is not available the makers furnish a small generator which can be driven from the line shaft and placed in convenient location. The chuck takes about the same amount of current as a sixteen-candle-power light. If for any reason the magnetic chuck is not wanted a special quick-acting chuck will be furnished. It has three external jaws operated by a single lever and one internal jaw which grasps the inside of the ring or other work being done, hold-

ing it from turning in such a way as not to distort it. For varying the depth of the feed the whole spindle mechanism and chuck is raised by an annular graduated hand wheel shown at the front of the machine. The spindle runs in adjustable bushings which may be taken up as the bearings wear.

The emery wheel is mounted in a crosshead at the top and is provided with a fast feed for roughing and a slow feed for finishing. The action of the feed is such that the wheel is moved in and out between the center and the circumference of the work that is being ground. The crosshead can be adjusted to grind the work either thicker or thinner at the center than at the circumference. The feed may be either automatic or by hand, as desired. An exhaust fan removes all dust, adding to the life of the machine and the comfort of the operator.

Goddard Rotary Surface Grinder.

The builders, the Goddard Machine Company, Holyoke, Mass., especially recommend the machine for grinding and fitting piston rings. This work can be handled in such a way as to meet the most exacting requirements at a small fraction of the cost of filing and scraping. The design is simple enough to allow the machine to be used by boys or unskilled labor. The makers will furnish the machine with a motor drive when so desired by the customer.

PIPE THREADING MACHINE.

The Merrell Manufacturing Co., Toledo, Ohio, is making a power pipe threading machine in two sizes, No. 8 and No. 12, having a combined range for pipe from 1 to 8 inches in diameter. Some of the features of this design are: the location of the cone directly above the spindle and the inclosing of the back gears within the cone where both they and the workman are protected; a quick opening and closing die head which may be operated while the machine is running; and an improved vise and feeding arrangement. The vise is self centering and feeds the pipe into the chasers by a friction lead screw connecting the vise frame to the die head, through a cam which closes the lead nut on the screw. The pipe can, however, if desired, be fed into the chasers by a hand wheel. In the continuous operation of this machine, on a given diameter of pipe the work may be cut to length and threaded continuously without throwing off the power.

THE MUELLER RADIAL DRILL PRESS FEED.

The Mueller Machine Tool Co., Cincinnati, Ohio, has designed a new feeding mechanism which they are applying to their line of radial drills. It is the belief of the builders that, while positive feeds are necessary in using drills and reamers made of high speed steels, yet there are some classes of work in which it is detrimental. In the arrangement shown in Fig. 1 either a positive or a friction feed may be used at the will of the operator. The spindle carries on the driving gear at its upper end a disk whose upper surface carries seven circles of steel pins. These pins engage with a steel pinion, with teeth of involute form, on the horizontal worm shaft, which drives the vertical feed shaft with the handwheel at its lower end. Extending through a hole in the center of this shaft is a rod having a knurled knob at its lower end and a small pinion at its upper extremity. The pinion meshes with rack teeth cut in a horizontal rod and by

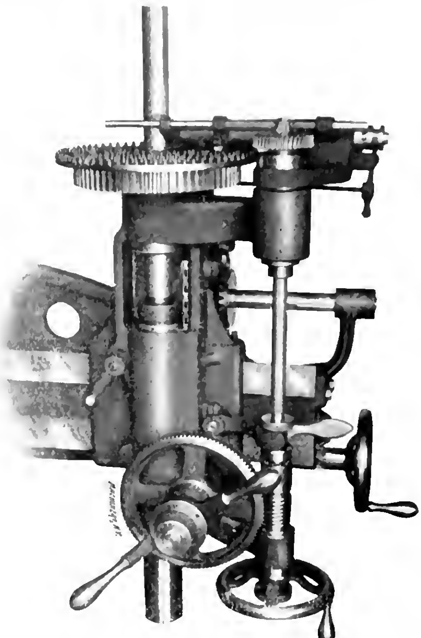


Fig. 1. The Mueller Radial Drill Press Feed.

this means the operator may shift the sliding gear to engage with any one of the seven circles of pins in the feed disk, thus giving seven changes of feed. The mechanism allows change to be made while the drill is at work. The upper worm wheel has its hub split and by means of a ring nut it

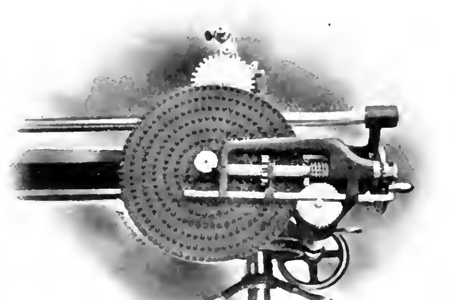


Fig. 2. Top View of Feed Change Mechanism.

can be locked to the vertical feed shaft if a friction feed is required. The automatic feed is tripped by disengaging a clutch shown on the end of the horizontal feed shaft.

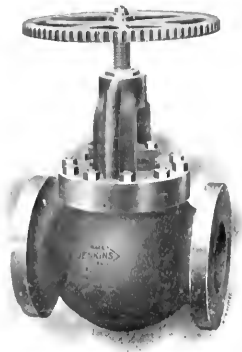
Fig. 2 is a view looking down on the top of the mechanism and shows quite plainly the means provided for varying the rate of feed.

THE JENKINS LINE OF EXTRA HEAVY VALVES.

Some time ago Jenkins Bros., of 71 John St., New York, placed on the market a line of extra heavy brass valves suitable for working pressure up to 300 pounds. This line proved very popular with their customers and a demand arose for a similar line of iron body valves. While heavy iron body valves had previously been built, they had all been built to meet special conditions, and consequently there was no standard design, the different sizes varying widely in their general

dimensions. The design of a standard line has now been completed, and every question which the manufacturers' experience in the making of valves could suggest has been thoroughly discussed.

These valves are made in sizes from 2½ to 12 inches inclusive, either screwed or flanged, and either globe or angle body style. They are guaranteed for a working steam pressure of 250 pounds, each valve being carefully tested before leaving the factory with 800 pounds hydraulic pressure. The materials used and the proportions of the different parts are such that the valves are expected to resist not only the stresses due to pressure, but also those due to the expansion and contraction of the piping, and other accidental strains. In the sizes 5 to 12 inches, inclusive, the valves will be supplied, if desired, with a by-pass cast integrally with the body. The by-pass on the 12-inch valve is fitted with an iron yoke bolted; below 12 inches the by-passes are fitted with brass bonnets which are screwed into the body. All the flange valves are fitted with manufacturers' standard extra heavy flanges, and the drilling, when ordered, will be in accordance with this standard unless otherwise specified. The makers advise the use of flange valves for sizes 7 inches and over.



Jenkins Extra Heavy Valve.

TUCKER SIGHT FEED LUBRICATORS.

W. M. & C. F. Tucker, of Hartford, Conn., make the two new styles of oil cups shown in the cuts below. In style *A* the body is of glass so that the supply of oil will be always visible; in style *B* the base of the cup is formed into a protective sleeve with openings to allow the oil level to be seen. The cap is fitted with two ports which serve the double purpose of


Fig. 1. Glass Body Lubricator.

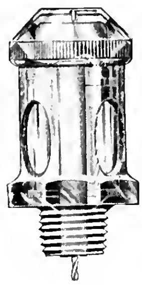


Fig. 2. Protected Lubricator.

making it easy to fill in any position and allowing the escape of air as well. The feeding is done by capillary attraction. The cup is arranged with a positive stop, and when turned in either direction against the stop the ports are closed and dust proof. This lubricator is especially adapted for small bearings running at high speeds and needing constant lubrication.

A COMBINATION HORIZONTAL AND VERTICAL DRILLING AND BORING MACHINE.

This tool has been recently built by the Hoefer Mfg. Co., of Freeport, Ill. Its purpose is the drilling and boring of holes in large castings simultaneously, when such holes are required to be at right angles to each other. It consists of a bed plate with a lower extension carrying a horizontal boring and milling machine of the usual type, and a rearward extension which forms a support for a radial drill. By this means, without moving the work, any point on the top or end surfaces of a heavy casting may be reached. Each spindle is driven with a separate belt from the line shaft so that they may be operating independently of each other.

EXAMPLES OF ELECTRIC WELDING.

The accompanying illustrations show some of the recent interesting work in electric welding done by the Standard Welding Co., Cleveland, Ohio. Fig. 1 is a spool or circular band of special shape made of cold rolled steel, the outside diameter of which is 13⅞ inches, and it is 7 inches long. It


Fig. 1.

is bent in the form of a circle and welded electrically, after which it is shaped by a special process. This band is used for winding the fibers of cellulose in the manufacture of artificial silk, and indicates the wide range of devices and machine parts that electrical welding is adapted for.

The second illustration shows a cylindrical body made from seamless drawn tubing with a cap electrically welded on one

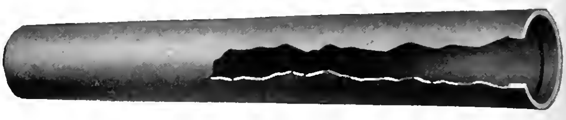
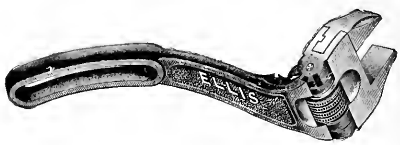


Fig. 2.

end and a band on the other, making an extra thickness of wall for threading on the inside of the open end. This is manufactured for the United States government for oil cans used with field limbers. The length of the complete tube is 21 inches and its outside diameter is something over 3 inches.

THE ELLIS COMBINATION WRENCH.

The illustration shown herewith is a view of a new adjustable S wrench. As shown in the figure, it may be used as an ordinary straight wrench, adjustable for various sizes of square or hexagon nuts and screws. It will be seen, however, that the handle is adjustable to a position on either side of the center line, making it a right-hand offset or left-hand offset adjustable wrench. This allows the tool to be used in cramped quarters where the use of other wrenches is out of the ques-



The Ellis Wrench.

tion. If desired, the upper straight jaw may be removed and a pipe jaw inserted. This makes a handy pipe wrench which will work around corners, behind pipes, and in other inaccessible places. The change from nut wrench to pipe wrench can be quickly made. It is especially recommended for use on automobiles by the selling agents, Patterson, Gottfried & Hunter, Ltd., 146-150 Center St., New York City.

* * *

The Pennsylvania Railroad Co. is electrifying part of the Long Island Railroad system and has recently made a contract with the General Electric Co. for the complete electrification of one of its lines running between Philadelphia and Atlantic City. The entire steam equipment of this road will be discarded, it being the intention to run all the trains with electric motors. About sixty miles will be electrified at an expenditure of something between $2,000,000 and $3,000,000.

MACHINERY.

February, 1906.

THE COLBURN MACHINE TOOL COMPANY'S SHOP.

DETAILS AND SPECIFICATIONS.

In the December number of MACHINERY were published details and specifications of a modern, mill-type building, and it was announced that we should later publish details and descriptions of several modern plants of medium size of other types of construction. We believe that information of this character will be appreciated by many who are investigating shop architecture. For the subject this month the new shops of the Colburn Machine Tool Co., Franklin, Pa., have been selected; they are an excellent example of what may be termed the standard type of steel construction in which there is a high runway or erecting floor down the center of the shop, with wings on either side for the smaller tools. We publish in this connection partial specifications of the plant and detail drawings of the most important features of construction.

The plant was completed in 1904 and is devoted to the manufacture of vertical boring and turning mills and universal saw tables. The buildings have walls of red brick with stone trimmings and the framework is of steel, making a practically fireproof construction. The main shop is 100 x 200 feet, three stories high in front to give room for the business and drafting offices. The engine and boiler house is complete in its equipment, power being furnished by a Nash three-cylinder gas engine, driving an electric generator from which current is distributed to the various parts of the plant and for operating the line shafting. Some of the machines are also direct driven by motors. The heating plant, furnished by the Buffalo Forge Co. is also installed in this building. The blacksmith shop is immediately back of the engine and boiler house and the lavatories at the extreme rear. The plant is located on property 512 x 300 feet on a branch of the Lake Shore Railroad. The equipment consists of new tools throughout and the entire plant is complete in its appointments and arranged with a view to the convenience and comfort of the employees.

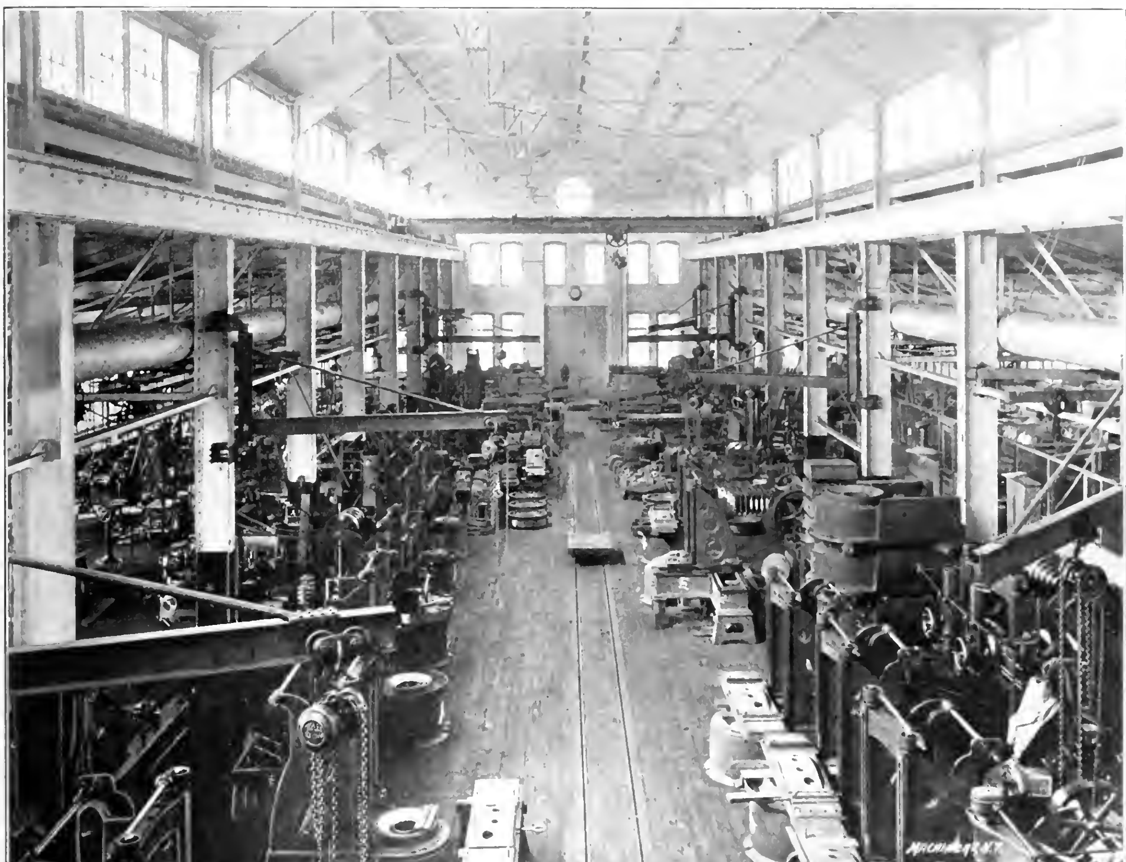


Fig. 1. Interior of Machine Shop.

In the specifications which follow the general articles pertaining to forfeiture, delays, payments, insurance, repairs, etc., are omitted as are also the sections pertaining to lathing and plastering, and plumbing, metal work such as ceilings, gutters, etc., painting, and glass and glazing. The specifications so far as published, however, are complete in all their items.

PARTIAL SPECIFICATIONS: LEHMAN & SCHMITT, ARCHITECTS.

Foundations.

EXCAVATIONS.—All excavations will be done by the Owner.

FOOTINGS.—The foundation walls and piers shall have footings of large flat stone 8 inches thick, laid in level courses in full beds of cement mortar, with the joints thoroughly grouted with same mortar.

The piers of columns are to be built of full size stone with bolt holes cut through the same.

The bearing stone for column bases to be smooth and dressed to a true and level surface.

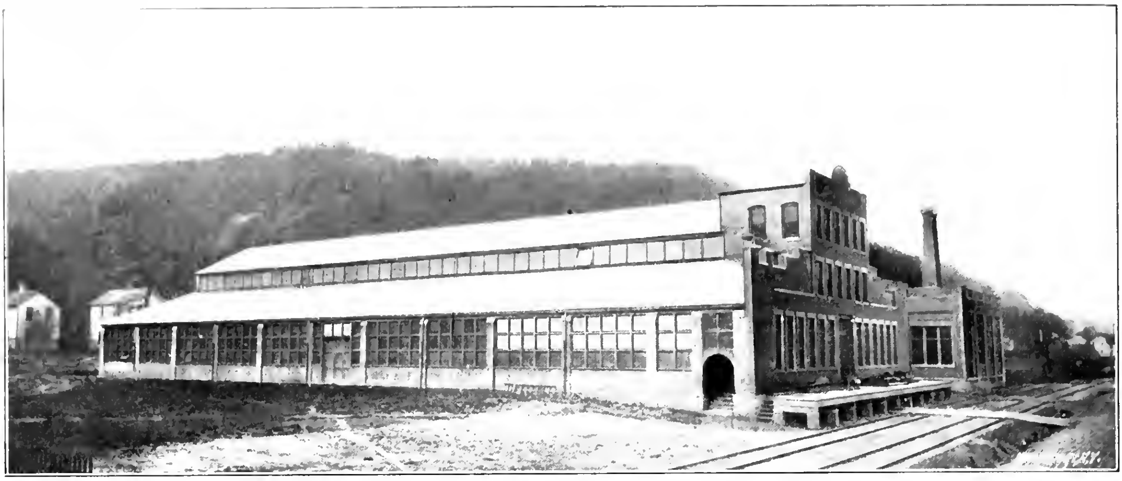


Fig. 2. General View, Colburn Machine Shop. Power Plant at Right.

PERCH STONE WORK.—All foundation walls and piers to grade line are to be built of large perch stone laid in random courses with square joints with one-fourth of all stone the full thickness of wall, the balance of walls to be laid up with two stones, all properly bonded together and laid with full beds and joints of cement mortar; all joints filled flush. The face of all walls to be rough hammer dressed and built to lines. The exposed walls on side and return to be rock-faced work with tooled margins.

MORTAR.—The mortar for all foundation work to be of cement and sharp screened bank and river sand, thoroughly dry, mixed to an even color before applying water and freshly mixed in such quantities as required for immediate use.

The filling of wall and bolt holes to be grouted with water and mortar so as to thoroughly fill all beds and joints.

The mortar shall be proportioned one part Empire Portland cement and three parts sand as before specified.

Fig. 3. Interior View in one of the Side Wings.

Mason Work.

The buildings to be constructed under these specifications consist of a machine shop, engine and boiler house, blacksmith shop, lavatory and wash house, and are to be located upon the premises approximately as designed by block plan.

The owners are to do all the excavating required and are to build all foundations, walls and piers for the various buildings to the grade line designated by the drawings.

All walls, piers, pilasters, smokestack and other work shown or indicated on drawings as brick work shall be built of well hard-burned brick of even color, regular shape and size, laid with full beds and joints of good rich mortar, with struck joints on all exposed interior and exterior surfaces.

All openings, unless otherwise shown, shall have brick releaving arches not less than 8 inches deep, no joints to exceed ½ inch in thickness. All brick work to be laid in regular bonds and level courses to lines stretched on both sides of the wall; every sixth course in all walls to be headers.

The filling of walls to be rubbed to proper beds and joints, the walls in all cases to be built level to the exact height of bottom of all floor beams and trusses, and after same are laid shall be built up level to the top of same.

MORTAR.—The mortar for all brick walls, pilasters, smokestack, etc., shall be of rich lime and sharp screened river or bank sand.

ARCHES.—Build all face arches, pilasters, reveals, brackets, etc., as shown.

BACKING.—Fill in and back up solid all stone or other exterior work point up close to all copings and caps and render customary assistance to other mechanics as required in general building construction.

COVERING.—Provide materials and labor to properly cover the walls from the weather, at all times and on final completion; repoint and clean all exposed brick work on fronts.

CENTERS.—The carpenter must furnish centers for each arch, templates for curved walls, also all blocks, strips or other woodwork required to be built into the walls during construction, and set all frames with proper braces.

FRAMES.—The mason shall assist in the setting of all frames and other work and will not be allowed to build arches or circular walls without the proper center or template; he will also be responsible to keep all work plumb, level and undamaged after the same is set in place.

FACE BRICK.—The exterior facing of all brick walls to be laid up with selected common brick, with red putty mortar with neatly troweled struck joints. The inside facing of all walls to be laid with white mortar, struck joints.

The pilasters on side walls to be built up solid around steel columns and finished with a stone cap.

The exposed surfaces of all brick walls at main entrance to be laid up with selected brick and red putty mortar, the same as exterior.

CUT STONE WORK.—The large shop windows on first story, side elevations, will have wood sills, all other windows in first, second and third floors are to have stone window sill, droved work and all sill except for windows in finished offices shall extend through the wall; all shall be cut with proper washers, lugs and drips.

The coping and sill courses on all exterior walls to be of 2½-inch thick sawed flagging with faces droved work.

The sill courses, second story front, to match window sills; the caps of windows on front to be droved work.

The steps and platforms to main entrance to be of hard sand stone, rubbed finished, set on brick walls and joints pointed with cement. The ashlar at each side of these steps to be droved work.

The exposed walls on side and the return 2 feet on the machine shop building and the front and return of engine

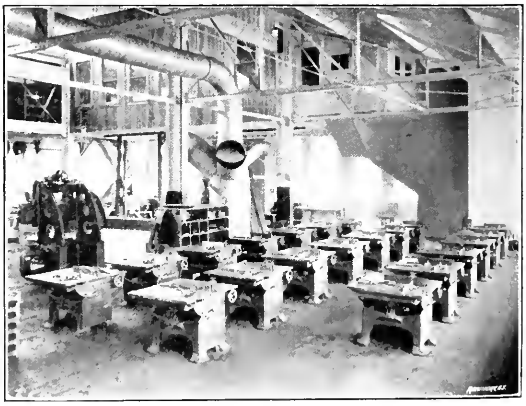


Fig. 4. View looking toward Offices, showing Colburn Saw Benches.

and boiler house building and the water table of all the buildings are to be rock faced work with tooled margins and wash.

The door sills to be same as water table course, but shall be cut with proper wash and lug, and shall extend over the full thickness of wall.

The piers under railway docks platform shall have 6 inch thick stone caps, the full size of piers.

The window and door sills of engine and boiler house, blacksmith shop, lavatory and wash house to be as above specified; all the window and door sills for these buildings shall extend through the wall.

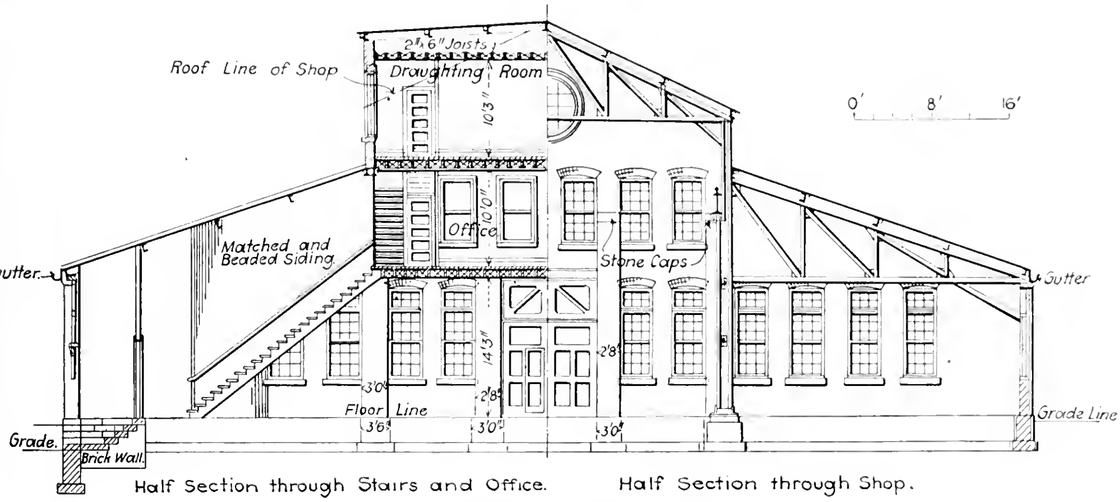


Fig. 5. Sectional Elevation through Machine Shop.

Damp Course.—Cover all outside walls at grade line with double course of two-ply tar roofing felt. This damp course to be the full thickness of wall.

Flooring.—The machine shop building and the blacksmith shop will be leveled to a surface 24 inches below the finished floor line by the owner. This space shall be filled up with clean cinders properly tamped, packed and rolled with a horse roller to a solid bearing 18 inches in thickness. The carpenter will lay wood sleepers, and the spaces between the same shall be filled up flush with crushed cinders well tamped. The cinders for all this work to be

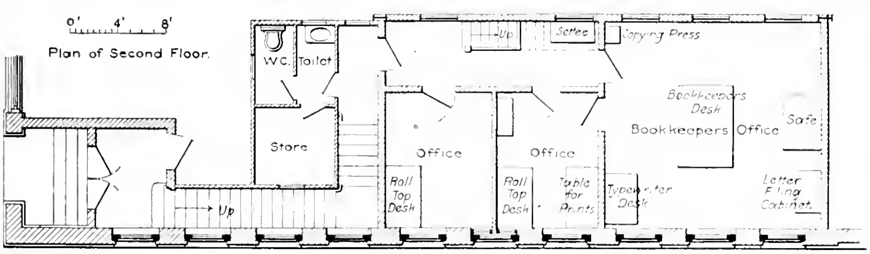


Fig. 6. Office Floor.

furnished on the premises by the owner, but shall be brought into the building, and all labor connected with spreading, packing and rolling the same to be done by the mason contractor.

The floor of engine and boiler house and of lavatory and wash house are to be of concrete 5 inches thick, which shall be graded in all directions, so as to drain to the outlets indicated on drawings.

These floors to be laid in two parts, the lower part $3\frac{1}{2}$ inches thick and the upper part $1\frac{1}{2}$ inch thick, the lower $3\frac{1}{2}$ inches to be composed of one part Empire Portland cement, three parts river sand and five parts 1-inch broken stone, all thoroughly mixed and worked before water is applied and after water is put on to be again thoroughly worked and laid down and properly tamped in place. The top finishing coat of $1\frac{1}{2}$ inch thick to be composed of one part Portland cement and three parts river sand, thoroughly mixed and worked and laid down into a uniform even thickness and finished with a wood float.

The whole floor to be graded and pitched to an exact pitch as directed. Each contractor shall submit with his bid a price per square foot for each concrete floor, to be added or deducted in case alterations are made.

Removal of Rubbish.—After completion of all this work the mason contractor shall remove all rubbish from the premises and leave the lot clean for grading, which grading shall be done by the owner.

Steel and Iron Work.

Tests and Inspection.—The contractor for this work shall afford the architects, superintendent or inspector all reasonable facilities for performing their work of testing and inspecting the materials and workmanship at the mills, shop and building; he shall also furnish, without extra cost, all test pieces required for said purposes, and shall pay the inspector for such tests and inspections a sum not exceeding $1.00 per ton of inspected material, which amount shall be paid upon the architects' order.

The contractor shall furnish the architect with copies of all iron detail drawings, which must be approved by the architects and inspector before the work is done. The responsibility for error in drawings to remain with the contractor.

To insure the acceptance of materials and workmanship, the test pieces must be of a quality conforming in every respect to the standard specifications, governing the physical properties of structural and special open hearth plate or rivet steel as adopted by The Association of American Steel Manufacturers, of August 9, 1895, which specifications are to form a valid part hereof as though fully written herein. All work delivered at the building must bear the inspector's mark of approval. No material shall be shipped from mill or shop until after inspector's approval. The acceptance of material or workmanship at the mill or shop will not be considered final, but the right is reserved to reject any material or workmanship, which, upon delivery at the building, shall prove defective at any time before the completion of contract.

Painting.—All surfaces that are inaccessible after being riveted, or that are inaccessible after erection, shall have two coats of pure red lead and linseed oil paint before riveted or erected. All work shall, after erection, be thoroughly cleaned with wire brushes and painted one coat of pure red lead and boiled linseed oil. No painting will be allowed in wet or freezing weather; all turned or planed surfaces shall be painted with a mixture of white lead and tallow before being exposed to the weather.

Schedule.—The work herein included consists in furnishing, erecting and setting in position, in full accord with the drawings and specifications, all the structural steel and iron work shown on the drawings and all work indicated on drawings as iron or steel, either directly or by comparison with general drawings, details or specifications, all of which, unless specially mentioned to the contrary, shall be included in this contract.

The general schedule of the work will consist of columns, girders, beams, channels, trusses, lintels, and such plates, angle connections, and other work, as required to complete the various parts of the work.

Columns.—The columns in side walls will be made of I beams with plate and angle bases and caps, riveted to same. The center columns will be made of plate and angles with base, cap and connections all riveted together. Each column to have such connections as required for bases, trusses, bracing and girders.

The base of each column to be anchored to the foundation with two bolts built into the mason work; these rods, with suitable tem plates, to be furnished by the owner and built in by the mason.

The columns in wash and locker room are to be round hollow cast iron with base and cap plates, all in one piece, both bearings turned to a true surface and the columns to be straight, true, and smooth castings.

Beams and Channels.—The beams for support of crane tracks, the rail for cranes, the channels for all roof purlins, the girders for

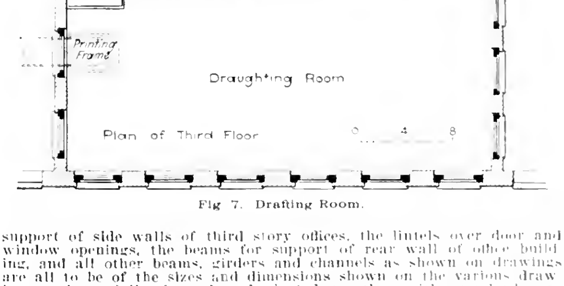


Fig. 7. Drafting Room.

support of side walls of third story offices, the lintels over door and window openings, the beams for support of rear wall of office building, and all other beams, girders and channels as shown on drawings are all to be of the sizes and dimensions shown on the various drawings, substantially framed and riveted together with standard connections, angles and plates. All roof purlins to be punched every 4 feet for $\frac{1}{2}$-inch bolt for securing wood nailing strips. All other iron work supporting or securing wood work shall have holes punched directly into same as may be required for securing wood work in place

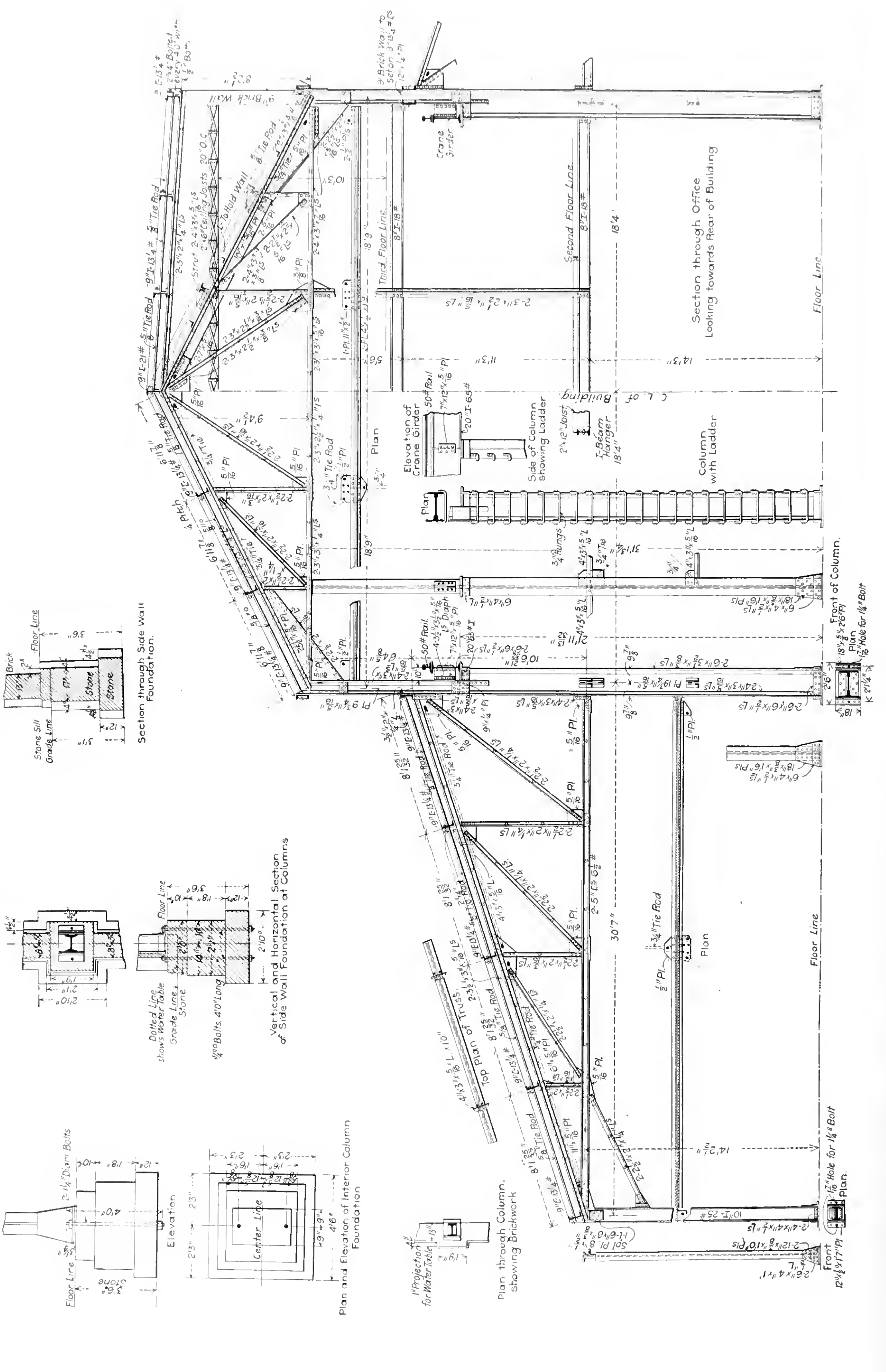


Fig. 8. Details of Steel Work and Foundations.

The bolts required for all such work to be furnished and secured by the carpenter.

TRUSSES.—The trusses for support of roofs are to be constructed of angle irons and plates, framed as shown by details, and all securely riveted together and to columns.

The main roof truss supporting rear wall of office to be reinforced with plates and heavy angles, suspension rods and beams as shown on drawings. All roof purlins to be riveted to trusses. All braces, struts, plates, ties, rods or other work shown shall be included.

LINTELS. All lintels formed of two beams are to have cast iron separators and bolts and shall be set on standard size wall plate.

RODS.—The columns and trusses are to be braced with temporary and permanent iron rods which shall be arranged in three panels and shall include the bracing of columns and upper and lower chords of trusses in panels as shown on drawings.

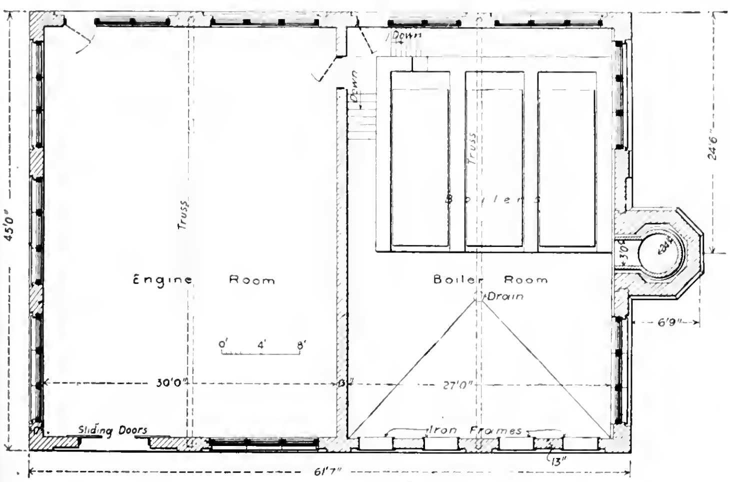
DOORS. The openings to boiler room for receiving coal are to have frames made of angle irons and plates, enclosing the entire opening the full width of walls, and shall have iron doors hinged to same and trimmed with suitable bars and fastenings to secure the same in place both open and closed.

All plates for this work to be 3-16-inch thick and all substantially riveted together.

The door at base of smokestack to have an angle iron frame and door properly hinged and trimmed in similar manner.

SIZES AND DIMENSIONS.—The size and weight of all material to be as shown by drawings and details; all material which is not figured shall be of such size and weight as required to complete the whole in accordance with the general drawings.

All rivets, bolts, plates, angles or other materials or work not especially mentioned to be furnished and included by this contractor so as to complete the entire framing in full accord with the general drawings, the whole of which to be erected, plumb, straight and true at all points and substantially riveted together.



Ground Floor Plan

Fig. 9. Plan of Power House.

Carpenter Work.

LUMBER.—All framing lumber such as joists, rafters, studding and beams, unless otherwise specified, shall be of thoroughly seasoned pine lumber of such sizes, shapes and dimensions as required by the drawings.

All finishing lumber and all finished wood work to be of the quality and kind hereafter specified, kiln dried, moulded and worked as shown by drawings.

CENTERS.—This contractor to furnish a center for each arch, template for all curved or octagonal walls, all blocks, strips and other wood work required to be built into the walls during construction, also all plates, boards or other rough lumber required for other mechanics' work.

CUTTING AND FITTING.—All framing, cutting and trimming wood work required for gas, water, steam, plumbing or other pipes, also all cutting and fitting of wood work as required to enable other mechanics to set their work in place, shall be done in such quantities and at such times as required to complete the various works on the building as shown by drawings or as may be required in order to fully complete the various parts as hereafter specified.

FRAMES.—All door and window frames shall be properly set and secured with braces and all sills and pulley stiles covered and protected during construction.

LINTELS.—All openings in brick or stone walls shall have suitable lintels of such size and radius as required for the various openings.

CLEANING.—This contractor shall, at all times, keep the building free and clean of rubbish, sweep out the entire building before painter's work is commenced, and as often as required remove the rubbish from the building and premises, and on completion remove all rubbish from the premises.

FRAMING. All headers and trimmers in all joists and rafters are to be framed together with duplex joist hangers of the size corresponding to sizes of timber.

The holes for all hangers to be bored 1-16-inch larger than size of hangers and the ends of all joists neatly fitted to hangers.

SIZING.—All lumber to be sized to an equal width.

FURRING.—All outside walls that are to be plastered shall be furred with 1 x 2 inch strips set vertically 16 inches to centers, securely nailed to plugs driven into joints of brick work every 2 feet in height. All floors, walls and partitions shall be furred as required for enclosing pipes of various kinds.

JOISTS.—The joists for office floors 2 x 12 inches, ceiling joists 2 x 6 inches, set 16 inches to centers. These joists shall be built into front wall with duplex wall hangers. The shop end of same to be framed into I beams with duplex I beam hangers bolted to I beam. The ceiling joists to be framed and secured to angle iron and walls.

The floors of machine shop shall have 4 x 4 inch wood sleepers laid 24 inches to centers on a cinder bed, and filled between same with cinders as specified on page 9.

These sleepers to be blocked and leveled up by the carpenter and the cinders packed around same by the mason.

The platform to have 8 x 12 inch beams, 6 x 12 inch joists and 2 inch plank flooring.

PURLINS. The purlins on machine shop roof will be of channels and each shall have 3 x 4 inch surfaced wood strips bolted to channel every 4 feet with $\frac{1}{2}$ inch bolts. The roof trusses for blacksmith shop, engine and boiler house are to have similar wood strips bolted to tops of same.

Similar strips shall be secured to all other iron framing to which wood work must be connected, the holes for all such bolts to be provided by the contractor for iron work, but all bolts for securing the wood work to be furnished by the carpenter.

RAFTERS.—The rafters for engine and boiler house and blacksmith shop to be 2 x 10 inch rafters, for lavatory and wash house 2 x 8 inches, all set 16 inches to centers. The ends built into walls and secured to nailing strips of trusses. The rafters of wash house roof to be supported on an 8 x 12 inch wood beam set on iron columns.

ROOF BOARDS. The roof boards for machine shop to be $1\frac{3}{4}$-inch thick pine matched and surfaced both sides and secured to strips bolted to purlins.

All joints on roof boards to be made on nailing strips and cut at an angle of 30 degrees across the board. The roof boards for other buildings are to be of $\frac{7}{8}$-inch common matched pine boards. All roof boards to be securely nailed to all bearings.

VENTILATOR.—The ventilator over blacksmith shop to be framed with 2 x 4 inch studs and 2 x 6 inch rafters, the exterior and interior sheathed with roof boards.

PARTITIONS.—All interior partitions on front stairway and offices to be framed with 2 x 4 inch studs with double plates and sills and double studs at all openings all thoroughly spiked together.

FLOORING.—The machine shop to have a $1\frac{3}{4}$ x 6 inch surfaced four sides pine floor, laid with close joints and securely nailed to sleepers. The floor in blacksmith shop to be finished with cinders; the floor in the engine house and wash to be of concrete.

The office floors on second and third floors to have a rough flooring of $\frac{7}{8}$ x 6 inch matched common pine flooring, laid diagonally across joists.

The finished flooring in these rooms to be $\frac{7}{8}$ x 3 inch matched quarter sawed Georgia pine, with all rough and uneven spots smoothed after laid and the whole floor left clean and smooth for painter's finish, all matched floor to be blind nailed every 16 inches.

WINDOWS.—All windows on front and rear elevations and the windows in offices of the machine shop, all windows in blacksmith shop, and the windows in engine and boiler house shown on drawings, with two or three sash each, are to have box frames made with $1\frac{1}{4}$-inch pulley stiles, $\frac{7}{8}$-inch boxing, $1\frac{3}{4}$-inch sills and heads, $1\frac{3}{4}$-inch blind stops and $\frac{1}{2}$-inch thick moulded sash stops and a bead finished on interior. The sash to be $1\frac{3}{8}$-inch thick, all double sash double hung with cast iron weights, bronzed iron axle pulleys and braided sash cord, trimmed with bronze iron sash locks, lifts and pulls.

The transom sash in all triple sash windows to be stationary.

The circular windows in boiler house and in end gable of machine shop to have $1\frac{3}{4}$-inch thick frames made of strips sawed to proper radius with $1\frac{3}{8}$-inch sash, all sash to be stationary.

The single sash windows in lavatory and wash house are to have $1\frac{3}{4}$-inch rabbeted plank frames with $1\frac{3}{8}$-inch sash hinged at bottom and trimmed with chain and spring catch.

The windows in side wall of machine shop are to be plank frames with $1\frac{3}{8}$-inch sash, the lower sash to be pivoted and trimmed with proper fastenings, the center and upper sash to be fixed.

The windows in lantern of machine shop to have plank frames with $1\frac{3}{8}$-inch sash, every fourth sash to be pivoted and secured with proper fastenings, the balance to be fixed.

The windows in lantern of blacksmith shop to be made in similar manner.

All interior or other frames not especially mentioned to be made to correspond with those specified.

The glass for all two light windows to be best double American glass; all other glass to be best double American glass; all to be bedded, bradded and back puttied and left whole and clean on completion of building.

All window frames and sash to be made of white pine lumber. The exposed parts of all frames to be made of selected material with not exceeding one $\frac{1}{2}$-inch knot in any one piece.

The lumber for all sash to be clear, all to be made according to detail drawings, properly set and secured in place and left in perfect working order.

DOORS AND FRAMES.—The frames for all doors in brick walls to be $1\frac{3}{4}$ inch thick, rabbeted as required. The frames for all doors in stud partitions to be $\frac{7}{8}$-inch thick, with $\frac{1}{2}$ x 2 inch moulded stop nailed on. The main entrance door to machine shop offices to have moulded frame and the entrance way finished with a moulded wood arch with panels as shown.

The exterior double, sliding and swinging doors are to be made with $1\frac{3}{8}$-inch frames, properly mortised and tongued together with $1\frac{1}{8}$ x $2\frac{1}{4}$ inch face, round corner matched strips, blind nailed and secured with screws to the framing. These doors to machine shop to be divided and swung in parts as indicated. All other doors are to be $1\frac{3}{4}$ inch thick with five plain moulded horizontal panels.

The doors in offices to have white pine rails and stiles and Georgia pine panels and shall be hand smoothed for oil and a varnish finish, all other doors to be of white pine, smoothly finished for painting.

Each interior door to be hung with three bronze plated loose pin steel butts and trimmed with mortise brass face lock with bronze knob, plate and trimmings.

The exterior single doors to be hung and trimmed in same manner.

The large double swinging doors to be hung with heavy wrought iron strap hinges bolted to wall and doors.

The sliding doors to be hung with approved iron top hangers and track secured with suitable sliding door locks.

Transoms on all exterior doors to be properly hinged and trimmed with transom lifts.

The exterior doors to coal room to be of iron, as before specified.

All hardware and trimmings to be of such patterns as may be selected by the architect.

Roofing.

The roofs of the machine shop building, excepting the three story portion of the front, shall have a slate roof. The three story part of this building and the roofs of engine and boiler house, the blacksmith shop and the lavatory and wash house shall have gravel roofs, all to be put on in the manner hereinafter specified.

Where slate roofing is specified cover roof boards with one layer of slaters' roofing felt properly lapped (3 inches); on the felt shall be laid with a 3-inch triple lap best quality C green slate, 11 x 20 inches and each slate shall be nailed with two galvanized iron slating nails. When building is ready for occupancy slate roofer shall return and repair any damages to slate caused by carelessness or by other mechanics' work, and shall leave the same in good repair upon the final acceptance of building.

Where gravel roof is specified the roofs to be covered with four-ply felt and gravel roof. The three-ply layer of best tarred felt shall be laid in the ordinary manner, properly coated with hot pitch and secured with tin caps and nails. After the entire roof is covered with this three-ply felt a separate layer of one-ply Warren's best asphalt shall be covered with hot asphalt over the entire surface and then the entire roof covered with hot asphalt and fine gravel, properly smoothed off.

The side walls and all projections above roof are to be flashed and cap flashed with best McClure's charcoal iron Ic roofing tin as hereafter specified. The felt to be lapped and turned up on all side walls and projections over the tin.

Sheet Metal Work.—All side walls and projections above roof are to be flashed with best Ic. roofing tin 12 inches wide, bent so as to lay 6 inches on the roof and 6 inches against the walls and properly secured in place.

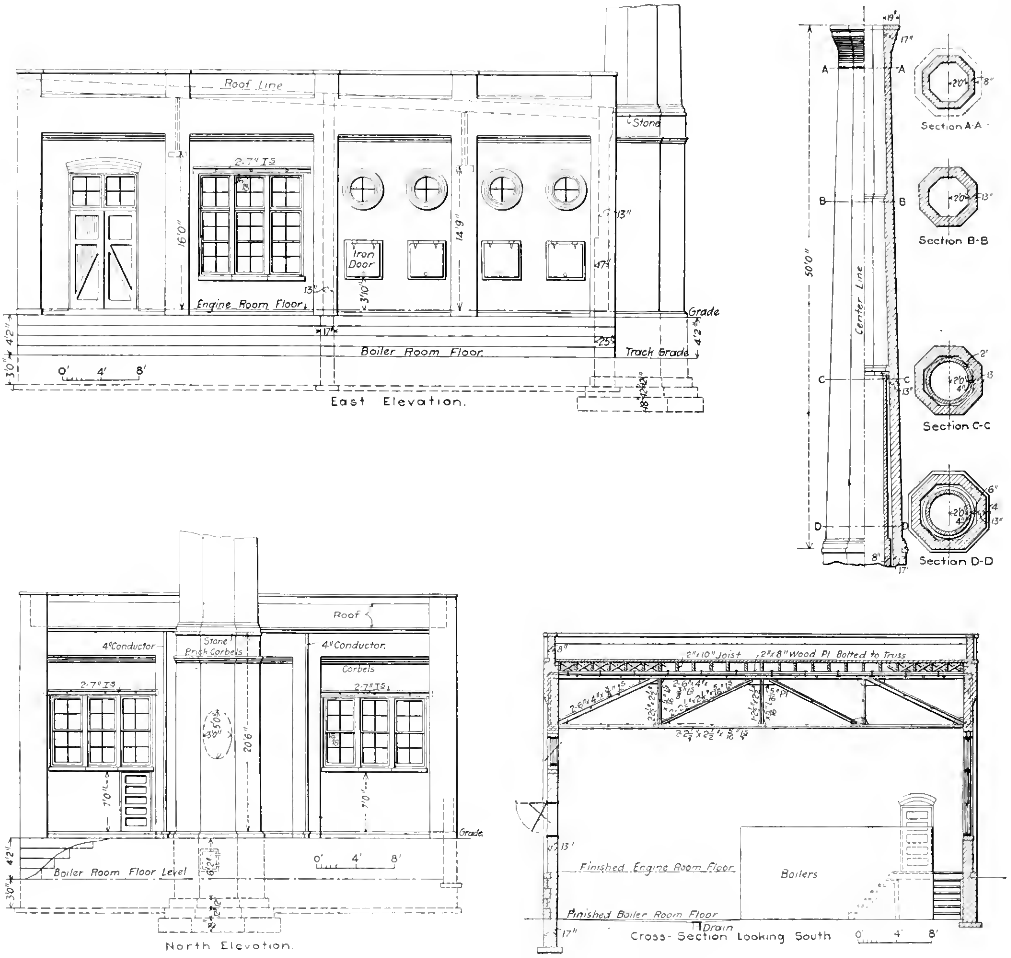


Fig. 10. Elevations and Sections of Power House and Chimney.

The roofing felt is to be laid over the same properly tarred and secured, and after this is applied cap all flashing with same tin, which shall extend to within 1 inch of roof. The upper edge to be turned into the joints of mason work properly plugged and joints cemented.

Ventilator Shafts.—The exterior of ventilator shafts, including jambs, bases and sills of all openings in same, are to be covered with same quality tin laid with flat lock and soldered joints and cleats properly nailed.

The windows in the ventilator of machine shop building will be flashed to root with 12-inch No. 22 galvanized iron flashing. The ridge roll on the ventilator will be of 18-inch galvanized iron.

* * *

For centuries man's productive power might be compared to quantity x, with an exponent of 1. In somewhat plainer language a man's working effort under the primitive conditions which existed in early times was absorbed in producing the food and simple clothing required for himself and those immediately dependent upon him. He left little behind to show that he had ever lived at all, and his descendants inherited little to ameliorate their miserable condition. But the exponent of efficiency was not 1, but rather a very small fraction greater than 1, so that gradually the condition of the human race has bettered, but it has taken untold centuries to increase the knowledge of constructive arts to such a state as qualify people to be considered civilized. Representing the condition of absolute savagery by a straight line, the improvement in living may be considered as a curve, which for thousands of years has pursued a course closely paralleling the base line, but constantly tending upward. During the past 150 years this upward tendency of growth has been very marked indeed, especially from a mechanical standpoint. The effect of machinery, especially the development of motive powers, like the steam engine, means that man's dynamic power has enormously multiplied. His work effort is not now almost totally absorbed in mere pursuit of food and protection, but each generation produces much more than it consumes, hence, productive power is continually increasing.

* * *

A convenient rule for approximating the safe load (in pounds) for chains is to square the diameter of the link in fourths of an inch, and multiply the result by 1,000. For example, a 3/4-inch chain should safely carry a load of $3^2 \times 1,000 = 9,000$ pounds. Another rule giving the load in English or long tons is to square the diameter of the link in eighths and divide by 10. For example a 3/4-inch chain would show by this rule a safe working load of $\frac{6^2}{10} = 3.6$ long tons, or 8,064 pounds. A 1-inch chain figured by these rules shows a safe load of 16,000 and 6.4 long tons or 14,336 pounds, respectively.

FORMULAS AND CONSTANTS FOR GAS ENGINE DESIGN.

SANFORD A. MOSS.

Definite rules will be given for the size of all of the more important parts of a gas-engine. The formulas are rational whenever possible, but in some cases are necessarily empirical. An attempt has been made to place everything on a more rational basis than usual. The constants and co-efficients given are for the most part taken from an investigation of current practice in gas engine design, made at Cornell University some years ago, and reported upon at the time.* An effort has been made to arrange everything in the most convenient form for a designer's use.

General Remarks.—The case to which the rules mainly apply is that of a single acting, trunk piston, stationary gas engine between 5 and 100 horse power. All pressures and stresses are in pounds per square inch, and all dimensions in inches. d is the cylinder diameter, and l the length of stroke, both in inches; p is the maximum pressure during normal operation. This varies from 250 to 350, the usual value being 300 pounds per square inch. The stresses in the various parts which are most important are the continuously repeated stresses due to constant repetition of this normal pressure, and not the occasional higher stresses due to a high value of p produced by excessive explosions now and then. Hence the normal value of p rather than the occasional extreme value is the one to be used in the formulas.

Thickness of Cylinder Walls, t.—This depends upon the stress s which can be safely allowed for continuous repetition. Considering the cylinder as an indefinitely long pipe with uniform fluid pressure, and adding a constant for reboring, crooked cores, etc., it may be shown that the thickness necessary for a stress s is

$$t = \left(\frac{1}{2s}\right) p\,d + \frac{1}{4}$$

Owing to the stiffening effect of the jacket, unstressed portion of walls, and cylinder ends, a rather high value of the apparent stress may be used in this formula. A safe value is 2450. Then

$$t = 0.000204pd + 1/4$$

If p has the usual value, 300, this reduces to

$$t = d/16 + 1/4$$

Thickness of Jacket Walls, T, and of Water Jacket, j.—These are determined almost wholly by considerations of molding and casting, and depend directly on the thickness of the cylinder walls t. Safe values are

$$T = 0.6t \text{ and } j = 1\tfrac{1}{4}t$$

Cylinder Head Studs; Number Used q, and Outside Diameter, o.—Satisfactory results will be obtained by use of the empirical expression

$$q = 2/3d + 2$$

The nearest whole number must of course be used.

If the initial load on the studs, caused by screwing them up, is not greater than the load due to the explosion, the latter gives the maximum stress s at the root of the threads of the studs. (The nuts of course may be carelessly screwed up tighter, causing unknown stresses.) It may be shown (since the area at the root of a thread is about 0.7 of the outside area) that the diameter necessary for a stress s is

$$o = \frac{1}{\sqrt{0.7\,s}} \sqrt{\frac{p}{q}}\,d$$

A safe value for the stress is 7800. Then

$$o = 0.0135\,d \sqrt{\frac{p}{q}}$$

If p has the usual value, 300, and q is 8 or thereabouts this reduces to

$$o = d/12$$

Length of Piston, L.—Let n be the ratio of the length of the connecting rod (distance between centers) to the radius of the crank. A usual value for this is about 5. Let b be the average bearing pressure on the projected area of piston (Ld square inches) during the explosion stroke. The piston must be long enough to give a safe value to b in order to avoid undue wear. It can be shown that the average total load on the projected area of the piston (due to connecting rod thrust only) is $pd^2 \times 0.22\pi/4n$. Hence the length of piston necessary for a bearing pressure b is

$$L = \left(\frac{\pi}{4}\;\frac{0.22}{b}\right)\frac{p\,d}{n}$$

A safe value for b is 7 pounds per square inch. Then

$$L = 0.025pd/n$$

If p has the usual value 300 and n the usual value 5 this reduces to

$$L = 1\tfrac{1}{2}d$$

The weight of reciprocating parts gives an additional pressure on the projected area of the piston, which is usually slight compared with the rod thrust. In cases where it becomes appreciable it should be taken account of, however, by adding the bearing pressure produced by weight to that produced by rod thrust, to obtain b.

Thickness of Rear Wall of Piston, z.—This depends upon the stress s which can be safely allowed. By considering the wall as a circular plate, fixed at the circumference and without ribs it may be shown that the thickness necessary for a stress s is

$$Z = \left(\frac{0.41}{\sqrt{s}}\right)\sqrt{p}\;d$$

Owing to the fact that ribs are usually added to help support the wall a high value of the apparent stress may be used in this formula. A safe value is 5320. Then

$$Z = 0.00562\sqrt{p}\;d$$

If p has the usual value, 300, this reduces to

$$Z = d/10$$

Length and Diameter of Wrist-Pin (Piston Pin), l'' and d''.—Let s be the stress in the wrist-pin due to continuous repetition of the pressure p, and b the bearing pressure on the projected area of the wrist-pin ($l''d''$ square inches) at the instant of maximum pressure, when the tendency to squeeze out the oil is greatest. The length and diameter of the wrist-pin must be such as to give s and b safe values. By taking the wrist-pin as a beam uniformly loaded, and supported at points l'' apart it may be shown that the diameter and length necessary for a stress s and a bearing pressure b are

$$d'' = \sqrt[4]{\frac{\pi}{4\,s\,b}}\;\sqrt{p}\;d \text{ and } l'' = \sqrt{\frac{\pi\,s}{4\,b}}\,d''$$

Safe values for S and b are 10,500 and 2,800, respectively. Then

$$d'' = 0.0128\,d\sqrt{p} \text{ and } l'' = 1\tfrac{3}{4}\,d''$$

If p has the usual value 300 then reduce to

$$d'' = 0.22d \text{ and } l'' = 1\tfrac{3}{4}d''$$

Area of Mid Section of Connecting Rod, a.—Let k be the factor of safety of the connecting rod or ratio of the breaking load to the actual maximum working load. Then the area must be such that k has a safe value. Let c be the distance from center to center of the rod, and r the radius of gyration of the mid-section. If the mid-section is round, having a diameter D, r^2 is $D^2/16$. If the mid-section is rectangular, having a height H then r^2 is $H^2/12$. It can be shown (by using Ritter's formula for long columns; end coefficient unity for ends free but guided; elastic limit of material, 35,000, modulus of elasticity, 29,000,000; neglecting obliquity and inertia of rod which nearly neutralize each other) that the area necessary to give a factor of safety k is

$$a = \frac{k}{14\,560}\,p\,d^2\left(1 + \frac{0.00012\,c^2}{r^2}\right)$$

A safe value for k is 3.9. Then

$$a = 0.000875\,p\,d^2\left(1 + \frac{0.00012\,c^2}{r^2}\right)$$

If p has the usual value 300 and if the mid section of the rod

*Sibley Journal, June, 1903. American Machinist, 1904 Vol. 27, page 482.

is circular and of diameter D and if the proportions are such that $1 + \frac{0.00012C'^2}{r^2}$ has a value of about 1.6 as is usually the case, this reduces to

$$D = 0.23d$$

Diameter of Crank Pin d'''.—This depends upon the stress, s, which can be safely allowed. Let l''' be the length of crank-pin journal, l' the length of the main bearing journal and let m be one-half of the distance from center to center of the main bearings. A center crank engine is assumed.

$M = m - (\frac{3}{8}\, l''' + \frac{1}{4}\, l')$ is a quantity needed in our formulas. (It is the arm of the effective bending moment on the crank-pin for the stress caused by the reaction on the main bearing due to the explosion. This bending moment is the only one which need be taken into account. It can be shown that all other effects, such as inertia, centrifugal force and obliquity of rod, effect of counter balances, weight of flywheels, belt-pull, etc., all practically neutralize each other.)

Then the usual relation between stress and bending moment gives as the diameter necessary for a stress s

$$d''' = \sqrt[3]{(4/s)\, M\, p\, d^2}$$

A safe value for s is 10,600. Then

$$d''' = \sqrt[3]{0.000379\, M\, p\, d^2}$$

If p has the usual value 300 and if the proportions are such that M is about $0.6d$, as is usually the case, this reduces to

$$d''' = 0.41d$$

Length of Crank Pin Journal l'''.—Let d''' be the diameter of the crank pin, and let b be the average bearing pressure on the projected area of the crank pin ($d'''\, l'''$ square inches) due to average value of the load during a complete cycle. The length of the crank pin must be such that b has a safe value, in order to avoid heating. It can be shown that the average value of the total load on the crank pin taken regardless of directions is about 14½ per cent of the maximum load due to the explosion. Hence the length of crank pin necessary for a bearing pressure b is

$$l''' = \left(\frac{0.145\,\pi}{4\,b}\right)\frac{p\,d^2}{d'''}$$

A safe value for b is 213. Then

$$l''' = 0.000535pd^2/d'''$$

If p has the average value 300 and if d''' is $0.41d$ as shown above to be necessary in an average case this reduces to

$$l''' = 0.95d'''$$

Dimensions of Crank Throws.—Let x be the thickness (in the direction of the shaft axis) of the throws of a center crank engine, y the breadth (perpendicular to the shaft axis) and d''' the diameter of the crank pin. Then safe values are

$$x = \tfrac{5}{8}d''' \text{ and } y = 2\tfrac{1}{8}x$$

Diameter of Crank-Shaft at Main Bearings, d'.—This depends on the stress s at the inner edges of the main bearing journals, which can be safely allowed. Let l' be the length of the main bearing journal. A center crank engine is assumed.

$M' = 0.325l' + 0.090l$ is a quantity needed in our formulas. (It is the arm of the effective bending moment on the crank shaft at inner edge of main bearing, for the stress caused by the reaction on the main bearing due to the explosion. It can be shown that this gives a moment equal to the combined bending and twisting moment, taking flywheel weight, belt pull, etc., into account.) Then the usual relation between stress and bending moment gives as the diameter necessary for a stress s

$$d' = \sqrt[3]{(4/s)\, p\, d^2\, M'}$$

A safe value for s is 9,500. Then

$$d' = \sqrt[3]{0.000422\, p\, d^2\, M'}$$

If p has the usual value 300, and if the proportions are such that M' is about $0.4d$, as is usually the case, this reduces to $d' = \frac{3}{8}d$.

Length of Main Bearing Journals, l'.—A single cylinder with two main bearings is assumed. Let d' be the diameter of the crank-shaft at the main bearing, and let b be the average bearing pressure on the projected area of a main bearing ($d'l'$ square inches) due to the average value of the load during a complete cycle. The length of main bearing must be such that b has a safe value, in order to avoid heating. It can be shown that the average value of the total load on the main bearings, taken regardless of directions, and taking account of belt pull, flywheel weight, etc., is about 1/3 of the maximum load due to the explosion. Hence the length of each main bearing necessary for a bearing pressure b, is

$$l' = \left(\frac{\pi}{24\, b}\right)\frac{p\,d^2}{d'}$$

A safe value for b is 123. Then

$$l = 0.001068pd^2/d'$$

If p has the average value, 300, and if d' is $\frac{3}{8}d$, as shown above to be necessary in an average case, this reduces to

$$l' = 2\tfrac{1}{4}d'$$

Outside Diameter of Fly Wheel, D.—The stress in the rim of a cast iron fly wheel of the usual type depends only on the velocity of the rim, V, in feet per minute. Hence the fly wheel diameter should be such as to give V a safe value. If N is the R.P.M., the diameter necessary to give a velocity V, is

$$D = \left(\frac{12\,V}{\pi}\right)\frac{1}{N}$$

A safe value for V is 3,220 feet per minute. Then

$$D = 12{,}300/N$$

Weight of Fly Wheels, W.—Let W be the total weight of all fly wheels, in pounds, for the case of a single cylinder, hit and miss engine. Let f be the speed fluctuation coefficient. This is the ratio of the difference between the maximum and minimum R.P.M. to the average R.P.M., N. The flywheels must be such as to give a safe value to f. Let H be the rated brake horse power, and D the outside diameter of the wheels. The greatest fluctuation is at light loads, and the least working load is taken as when the engine misses three times between each fire. Then it can be shown (on the basis that maximum indicated horse power is 1.4 times rated brake horse power, H, that the radius of gyration of an average fly wheel is 0.83 of the outside radius; and that the ratio of the energy added to the wheel and causing the maximum acceleration in the case considered, to the net indicated energy developed per cycle if exploding every time, is 1.197) that the fly wheel weight required to give a fluctuation coefficient f is

$$W = \frac{272{,}300{,}000{,}000}{f}\;\frac{H}{D^2N^3}$$

A safe value for f for ordinary engines is 0.054 (5.4 per cent). Then

$$W = 5{,}000{,}000{,}000{,}000\,\frac{H}{D^2N^3}$$

If we have the average value of the rim velocity above found so that D is about $12{,}300/N$, this reduces to

$$W = 33{,}000H/N.$$

* * *

One drawback to the extensive use of high-speed steel for drilling is the cost of twist drills and the increased liability to breakage when used for rapid production. In commenting on this fact the editor of the *Railway Engineer* says that one of the causes of the failure of high-speed drills in Great Britain is that the men cannot be depended upon to slack off the feed when the material at the bottom of the hole is getting thin. The result is that the heavy pressure necessary to force the point of the drill into the work pushes the drill through the thin bottom and often breaks it. Unconsciously this comment is an arraignment of modern drilling machines as it is practically a statement that the spring of tools is excessive when working. If the drilling machine is stiff enough to carry the drill with the required feed without excessive springing the breaking through of the point of the drill when nearing the bottom of the hole should not cause it to "hog in" excessively and cause breakage. It is only when the design is weak that such troubles as this occur.

* * *

The best grade of anthracite coal measures about 32 cubic feet per ton of 2,000 pounds. Poor grades require more space, but if an excess of stone is carried less than 32 cubic feet may weigh a ton.

ESTIMATING TIME ON MACHINE WORK.

J. H. VAN YORX, JR.

To cover the ground which the editor in the October number of MACHINERY evidently desires, in calling for data upon estimating, would take a long series of articles, if not a volume, to include the different phases of methods. It would appear that widely distributed short articles would suit the purpose to better advantage. This article is written with that idea. What few points are here covered may be an aid to some and to these same points others will take exception.

At best "estimating" is a polite and dignified term for guessing, and a man may be a good guesser or a bad. One who may be considered an accurate estimator in one environment would be a bad guesser if placed in another. The man who lays down a rule and rigidly follows it will surely come to grief sooner or later. There are, however, certain general rules to be followed in a general way. For instance, we know that a certain machine which travels (or the piece travels, as the case may be,) at a certain speed and with a certain feed will accomplish a certain amount of work in a given time; but here is where our knowledge ends and our guessing begins. This knowledge is often only a small proportion of the work to be performed. A certain gentleman who considered himself and was generally considered to be an accurate estimator, always allowed one minute to put a piece into a machine and one minute to take it out, no matter what the piece was when in some cases it would take ten minutes at least. He would allow too much time, according to a set rule, in another direction, and when the mistakes were averaged up they generally came something under actual time. This was laid to unnecessary losses, and he was considered a "close estimator." He was fortunate in having his set rules counterbalance each other. We all have our weaknesses of judgment and the "pot cannot call the kettle black" with consistency. Therefore we guess, in spite of the fact that a stop watch can be held to get accurate time for putting pieces of work into the machine, setting cuts, grinding tools, etc. The time thus obtained is accurate knowledge for that piece and that machine at that particular time, but it will be useful again only in estimating upon that same class of work. If this statement does not bring out strong protests from pens, it will from minds of a number who think they know because ninety out of every hundred of their estimates prove to be good guesses. The best that estimating can do, in the writer's opinion, is to establish limits based upon good judgment, either side of which it would be dangerous to go.

The machine shop is full of surprises and unusual conditions, no matter how familiar we become with it, and if they are not agreeable ones, some one must pay for them. It may be a good excuse for the estimator that certain unlooked-for conditions are unusual and cannot be considered. An uncontrollable condition unexpectedly arising may "let him out," as far as his work is concerned, but it does not pay for the loss. On the other hand, an estimator cannot add four or five hundred per cent to cover this, for he would drive all trade away with his high prices. The estimator, then, is a prophet, and a prophet is one who guesses at what is about to happen. To illustrate: a few days ago a simple job was given to a man on piece work, upon which there was an estimate of ten minutes for each piece. The piece was an ordinary nut 1½-inch hole, twelve-thread standard, to be chucked, tapped, faced and counter-bored. Actual time taken for the work was something under twelve minutes each, yet this man turned in his contract card, losing double the worth of the job. The facts of the case were that thirty-eight pieces had been made before eight good ones were obtained. The trouble was with the thread; the stock was changed, and the trouble grew worse rather than better; the tap was experimented with in every conceivable way, and finally a third lot of stock was tried and the job was finished in good shape. That, of course, was not "up to" the estimator, but the shop had to pay for it just the same. That is one thing; here is another. A piece was to be bored on a horizontal boring machine; the piece was simple in appearance with a bearing in which a rack was to operate. At two different points in this bearing were openings for rack pinions which operated the rack. The actual machine work amounted to but little, the measurements were most difficult to get, they had to be accurate, and there was no point from the outside from which to measure. It had to be done through a small opening through which the hand was to be passed. Here a new difficulty arose. The workman's hand was too large to pass through the opening and as the foreman's hand was smaller he had to do the measuring. Altogether, the time estimate was knocked into a "cocked hat." This estimate was the composite of several others. There is no rule to cover these occurrences, particularly in a shop where a variety of work is done. In this case a jig would have been out of the question as the job was "special" and would in all probability never be done again. A person who takes known figures and facts ceases to be an estimator and enters another class.

The foregoing is merely to show that what follows may be true in general of the conditions by which the writer is surrounded (a machine shop, manufacturing boring mills and lathes), yet would perhaps be totally in error for another, who might well say that this article is wholly incorrect. The writer might return the compliment for any that he might write.

One hard and fast rule that is always well to follow is: When in doubt be liberal.

The ever-increasing scope of turret machine work, causing a continual change of conditions, adds to the difficulties of accurate estimating. The number of pieces to be done, the kind of tools to be used, the location of the place where they are kept when not in use, whether the workman gets his own

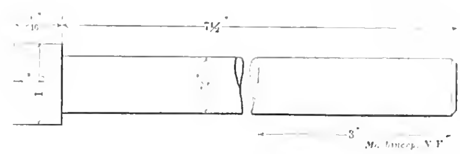


Fig. 1. A Sample Screw.

stock or has it brought to him, whether it is in a rack near his machine (if he is to use bar stock) or if it is outside around the corner, two blocks away. We can figure the time to make a screw like the one in the accompanying sketch (Fig. 1) in a number of different ways.

FOR ONE PIECE.

	Min.
To set up machine	30
To size and start	1
To cut to shoulder	4
To cut thread	2
To cut off	1
To get sizes	1
Extras	2
	41

FOR THIRTY PIECES.

	Min.
To set up machine (average)	1
To size and start	1
To cut to shoulder	4
To thread	2
To cut off	1
To get sizes and grind tools	1
Extras	2
	12

The above estimate for semi-automatic turret lathes.

If the workman gets his own stock from five to fifteen minutes would have to be added according to circumstances; this would leave the screw ready to be slotted and polished. Now to analyze the figures.

For screw machine work of this class it has been found by actual timing that an average of one-half hour to get the tools properly set and stock in the machine ready to start the work is a liberal allowance. This figure is used more or less arbitrarily unless there are known conditions which would change it. To "size" the stock and use the starting tool takes approximately one minute. The diameter of the stock used in this class was 1 1-16 inch, making about 160 feet of metal to turn off at 1-80-inch feed. This, at 40 feet per minute, would be four minutes. It can be seen right here that a difference would arise if conditions should force a limit of 30 feet or

allow 70 feet, or if the stock were poor 1-100-inch feed might have to be used. From tables we find that a piece 7/8 inch in diameter, threaded 3 inches, will take a fraction over one minute; this would be called two minutes. Again tables show cutting off 1 1/16-inch stock to take approximately one minute. No time would be allowed to sharpen and keep the tools in shape for one piece, for they should be in good condition both when a workman receives them and when he has finished with them. One piece ought not to materially affect their condition. A more liberal allowance should be made for getting sizes (according to the number of sizes to be gotten) on one piece than on a number, and while less time would be allowed for this item in larger numbers the amount allowed for the care of tools should be increased, both, of course, to be within reasonable limits. For larger numbers an allowance of 10 per cent of the machining time is made. An allowance for "extras" or unexpected delays of 25 per cent for one piece, dropping to 10 per cent of the total time for large numbers, is made. The matter of setting up the machine will fade to insignificance if five hundred or a thousand pieces are made.

There is still another way to consider a piece of work which is to be estimated. Shall we figure for the time in which it will be done, or for the time in which it can be done? The figures shown are estimated according to the first, with a consideration for the legitimate causes for loss of time. If the latter or record time is to be figured, less time would be allowed for setting up, fractions would be treated with more respect, and no "extras" would be allowed.

Another class, among the many classes of work performed upon these semi-automatic turret machines, is bevel gears, and here again the varying conditions admit of no rule. It is largely a matter of special tools, the number, efficiency and quality of which are dictated by the quality and quantity of the work to be performed. More time must be allowed for setting up because of their weight and the greater difficulty of setting the cutters properly in these tools; also their care. On some of this class of work an automatic feed can be used, on others a hand feed must be used. After the turret with its tools are in operation, about one-fourth minute is the amount to be allowed "from tool to tool." An extra amount must be allowed for putting a piece into a machine and truing it up and also for taking it out, if it is not made from bar stock. When bar stock is used it is cut off and drops and can be picked up and laid aside when the next cut is being taken, therefore no time is granted for this. With separate pieces this is not true, as the piece must be secured in jaws or a fixture and be taken from them in separate operations.

The automatic screw machine is more certain to figure upon as it loses no time through its individuality (speaking of a good quality of machine). In certain classes of work, however, it is much slower than the hand machine, because, not being intelligent, it cannot take advantage of small spaces and does considerable air cutting; it recognizes no differences or sand spots in the stock, etc., and it does not swing the tools into place as rapidly in small work. In other words, an automatic machine can lose time automatically as well as to save it. When these machines are run in "batteries" another element enters. Where four of these machines are kept in operation by one man, twenty minutes per running hour is liberal to allow for each machine. Excepting in special cases, about the same time must be figured upon for five machines as for four since the gain is nearly counterbalanced by the losses. When three machines are operated the individual difficulties or characteristics of the work itself begin to become more pronounced, but in general about fifteen minutes per running hour is safe for conservative estimates. The writer will not enter further into the troubles an estimator may find laid up for him when attempting to figure upon from five to ten machines with one or two operators. What has been said above regarding the automatic screw machines might also be reiterated of automatic gear cutters, particularly if the run of work is small in size and the number of pieces reasonably large, requiring frequent changing, but few "settings up" of the machines.

In small lathe work the actual machining of parts can of course be easily figured. Where the pieces are light enough to be handled and put in on centers, a half minute is sufficient for putting in and another for taking out. If arbors are used, from one to two minutes (ordinarily) are allowed, according to the piece and the position of the arbor press. Here, as with the hand screw machine, we allow 10 per cent loss of time for a journeyman and an additional 25 per cent as an average for an apprentice. The latter figure will make many people say funny things, and they can immediately point to boys of whom this is not true; so can the writer. It is a figure which would be much less in a small shop or department where much care and attention can be given and much more where the department is large and little or no attention is paid to the apprentice beyond what he can pick up from his fellow workmen with an occasional hint from the foreman when his turn comes. For obtaining roughing sizes one-half minute is allowed and for finishing sizes one minute. This time should be sufficient to cover the care of ordinary turning tools, and is usually found to be liberal for direct measurements.

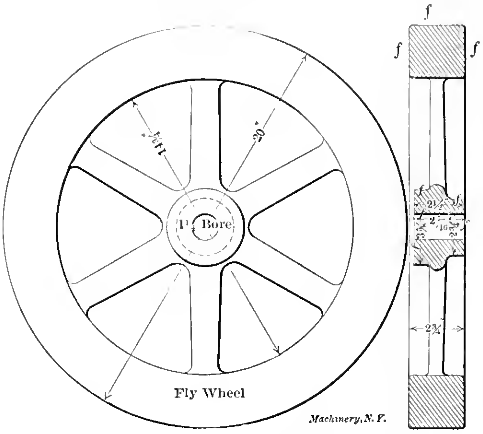


Fig. 2. A Boring Mill Job.

In figuring work for boring and turning mills the figures depend upon the machine having a double or a single head, as to whether it is a side head mill, power-handled, equipped with brakes and speed devices, or not. A knowledge of the quality of finish is absolutely essential for anything like intelligent estimating. The writer got into serious trouble on one occasion because of the meager information furnished (the details are given below). Forty-five minutes were estimated for doing a certain piece of work. The interested parties replied in a somewhat sarcastic vein that these pieces were done by them now in thirty-five minutes, and they were not satisfied with that. A representative called upon them and with information thus obtained found that the piece could have been done in about twenty-five minutes. A first-class finish and a particular job had been figured upon when a single roughing cut of fully 1/8-inch feed would have done. Here is the original estimate, based upon fifty pieces, speeds of from twenty to fifty feet per minute and feeds of from 1-16 inch to 1/4 inch per revolution.

	Min.
Set up machine (average)	1
Set piece in machine	2
Rough O. D.	5
Rough both rims (special tool)	8
Finish both rims and face (special tool)	6
Take from machine	1
Reset machine and piece (average)	2
Face, turn and round hub	3
Take from machine	1
For sizes and grinding tools	12
Extras	4
	45

The following is the estimate based upon the information later at hand:

	Min.
Set up machine (average)	1
Set up piece	2
Rough O. D.	5
Rough rims (special tool)	6
Take from machine	1
Reset machine and piece (average)	2

	Min.
Face and rough hub	1
Take from machine	1
Sizes	4
Extras	2
	25

It will be noted that some operations are not mentioned. These were done at the same time that others were being done, therefore no mention is made of them.

The following is an estimate upon some double cylinders, shown in Fig. 3:

	Min.
Set up machine (average)	2
Set piece in machine	5
Bore (2 cylinders, 2 cuts, 1-16 feed at 40 feet)	30
Facing (2 cylinder)	2
Chamfer (2 cylinder)	2
Sizes, etc.	9
Take from machine	1
Change from cylinder to cylinder (special fixture)	2
Extras	6
	59

Allow one hour.

There are all kinds of slide rules to be used in this work and all sorts of complicated diagrams which are great time savers to those who are constantly using them and are in practice, but for the most a few simple tables for different materials, comprehensive at a glance, such as for cutting areas at different feeds and speeds, for gear cutting, for chucking, drilling, etc., are all that are needed. A dozen or two slide rules and diagrams might help some of us the way old Jones, the bookkeeper, was helped by an adding machine. Jones always came home regularly at 5 o'clock for a great many years. His employer was persuaded to put a new adding machine into the office for Jones's use.

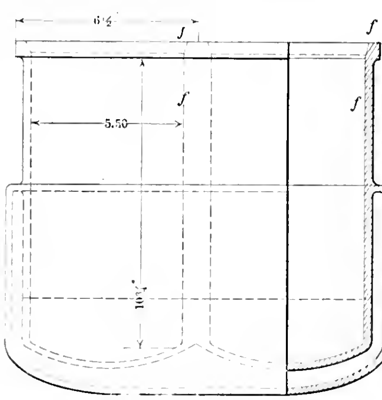


Fig. 3. Double Gasoline Engine Cylinder.

Jones used it and did not show up at his home until after 6 o'clock for several nights. Jones's wife inquired the reason for this unusual occurrence, and he replied that "the boss" had gotten him a "new fangled" adding machine, and he had to foot the columns afterward to see if they were correct.

A person must be familiar with the work and the methods which ought to be employed in handling it, the capacity of the machine to do the work, the relation of one operation to another which is to follow, and above all, the use of common sense and good judgment ahead of all rules and regulations.

The foregoing hints at methods rather than attempting to cover with definite figures a subject of such breadth.

* * *

After a thorough investigation of reasons for the lack of endurance of fence wire manufactured in the last few years as compared with the superior wire of twenty years ago, the Department of Agriculture at Washington has concluded that electrolysis is responsible for most of the trouble. The wire now put out, the expert of the department says, contains magnesia unequally distributed. This forms a resistance to the passage of electricity, and hence follows the electrolysis. Much of the wire manufactured to-day lasts but five years, while but a short time ago it was not uncommon for fence wire to be serviceable for twenty years.

LABORATORY TRAINING.

C. H. BENJAMIN

The use of laboratories in the training of mechanical engineers is comparatively a new development.

I remember in my own college experience Rankine's "Steam Engine and Other Prime Movers" in the class room, the drawing of beautifully tinted engines, copied from some textbook, and the taking of diagrams with a Richard's indicator from the one small engine owned by the institution. This last performance was my sole training in laboratory practice. As a matter of fact, the engine was not connected with any steam line until several years after its purchase and the indicator practice was imaginary.

During the past ten years the engineering laboratory has developed rapidly, and is now generally recognized as the most important agent in the instruction of mechanical engineers. The function of laboratory apparatus and machinery is twofold—to illustrate natural phenomena and the laws governing matter and force, and to train the student in the actual manipulation of such instruments, machines and engines as are naturally connected with his intended profession.

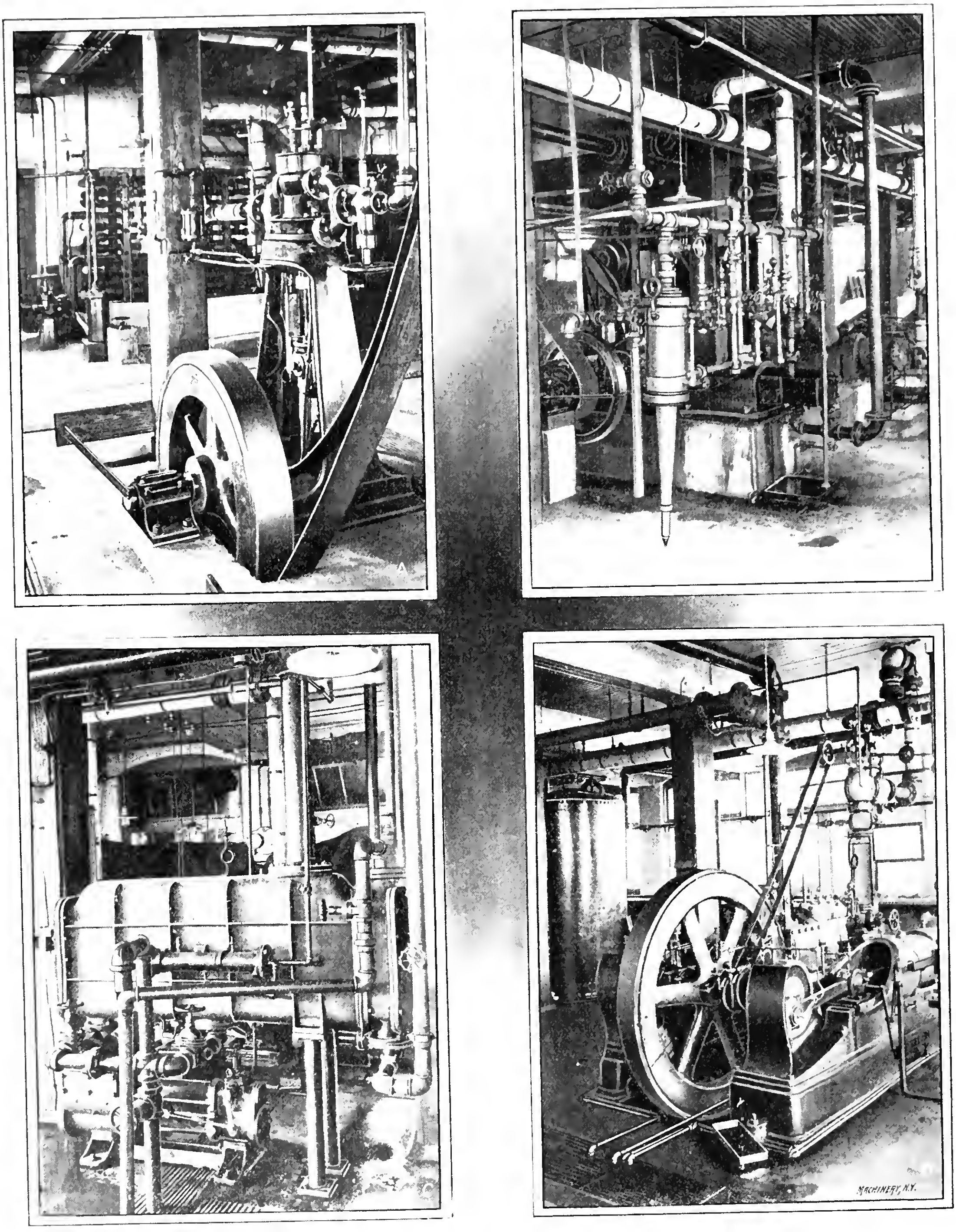
The old-fashioned physical or chemical laboratory with its array of apparatus for the sole use of the lecturer had the former function. The latter is, or should be, the function of the modern laboratory, be it physical, chemical, engineering, or what not; at least a place where the student may take things in his own hands and *do* with them.

There is a present-day demand for young men who know things and who know how to do things. There is also a demand for young men who can think *new* things. It is the function of the technical school to supply these demands, and the laboratory is the most important agent in doing this. Certain laws and principles are enunciated in the classroom or are worked out on paper in the drafting room, but it is in the laboratory, if ever, that the student is convinced of their truth. One physicist remarked to me recently that he was tired of seeing students rediscover known laws, but after all that is what each of us must do, in one way or another. A man's faith in either religion or mechanics comes by practice, and a paper faith is easily torn.

A laboratory, then, should be so equipped and officered that it may solve the problems of every-day engineering practice. And first, it should contain real machines and real engines. As far as possible these should be of ordinary commercial types, such as the student is likely to meet after graduation. An engine built specially for a laboratory and resembling no other engine gives false impressions and handicaps the experimenter. Second, the student should understand the machine and know the reason for every detail of construction. It is entirely possible for some students to make efficiency tests on an engine and not know the difference between a crosshead and stuffingbox. Third, the student should learn how to care for and how to run each engine or boiler or machine, and this knowledge should be acquired by continued practice under the supervision of a competent engineer. It may seem unnecessary to call attention to this, but in some laboratories it is not done, and some technical graduates know no more about running an engine or firing a boiler than they have learned by observation. Fourth, the would-be engineer should learn how to make the ordinary commercial efficiency tests according to the generally accepted standards and how to calibrate accurately the apparatus used in making such tests.

There has been considerable discussion of late as to the advisability of using printed forms and instructions in the laboratory. There is no doubt that the use of such forms has been abused in some instances, so that too little was left to the judgment of the student. I have seen printed logs for use in an engine test in which all the calculations were detailed, even the logarithms being located and nothing being left to the observer except the setting down of the data and the results in the blank spaces reserved for them. On the other hand, to attempt to teach the beginner how to make a standard evaporative test on a boiler or a standard efficiency test on a compound engine, without the use of printed forms to guide him, would be a sinful waste of time and would usually

entail slipshod work. In all so-called commercial tests for efficiency the printed logs and report blanks should be used as a means of training the student in the accepted methods for conducting such tests, but helps to calculation should be omitted. In the minor experiments, such as the calibration gation that student or instructor need never be at a loss for subjects. Neither does the laboratory need to be elaborately equipped for this class of work. Given steam or air or gas, some piping and engines of some sort and the ingenious investigator will improvise his apparatus as he goes along.



A Ice Machine, Ammonia Compressor and Condensing Coil.
B.—Apparatus for Testing Steam Engines.
C Condensing Apparatus and Vacuum Gage Tester.
D.—Ingersoll-Sergeant Air Compressor and Receiver.

FIG. 1. VIEWS IN ENGINEERING LABORATORY OF CASE SCHOOL OF APPLIED SCIENCE.

of gages and indicators, the log and report consist merely of sheets ruled in columns with appropriate headings. Fifth, the student should make such original investigations as the state of the art and the apparatus in the laboratory may warrant.

There are so many problems awaiting experimental investi-

Here is where the originality and the independence come in. No printed forms, no set rules, no exact order of procedure is now possible. The path is a new one—sometimes not even a blazed trail—and the experimenter must feel his way. He may or he may not solve the problem, he may or he may not produce anything for the benefit of the engineering world, but

the work will have benefited him and given him a training of hand and eye and mind which he never could have acquired in traveling the beaten paths of the ordinary laboratory practice. At the same time, without the preliminary training in the most direct and efficient methods of laboratory work, which he has acquired by the use of rules and forms, he would be at a great disadvantage in this new and broader field.

Americans have been criticised for their lavish expenditure in apparatus and meager supply of instructors, and the criticism is a just one. Most laboratories would be improved by exchanging some of the machines for good teachers. But what shall we do? It is much easier to get $10,000 for new apparatus than $50,000 to endow a professorship. Shall we refuse the apparatus or shall we accept it and do the best we can under the circumstances? And then, the modern technical school is sadly embarassed by its wealth of students. For every hundred dollars received for tuition it costs two or three hundred dollars for education and the more students the greater poverty. Shall we turn away the applicants or shall we take them and again do the best we can?

One instructor to every machine and to every five or ten students is an ideal arrangement, but how shall it be brought about? None of us can do the quality of work we did in the old days when the class in mechanical engineering numbered four or five men and the professor knew each one by heart.

I would like to describe briefly the power laboratory of the Case School and indicate how it is being used, as an example to illustrate what has just been said.

The building is of brick in the so-called slow-burning or factory type of construction and has two floors, the lower for engines and heavy machinery, the upper for transmission machinery and apparatus of a lighter sort. The lower floor is 48 by 96 feet in dimensions, without any dividing walls, and is well lighted on three sides. The floor is of concrete so sloped as to drain toward the center line and is crossed by a system of underground conduits covered with removable iron plates, so that any water which is spilled finds its way by gravity to a trap located in a shallow cellar at one corner. All drips from the engines are carried in these same conduits. All clean water discharging from condensers or mains is collected in a hot well, located in the cellar, and pumped to the boilers.

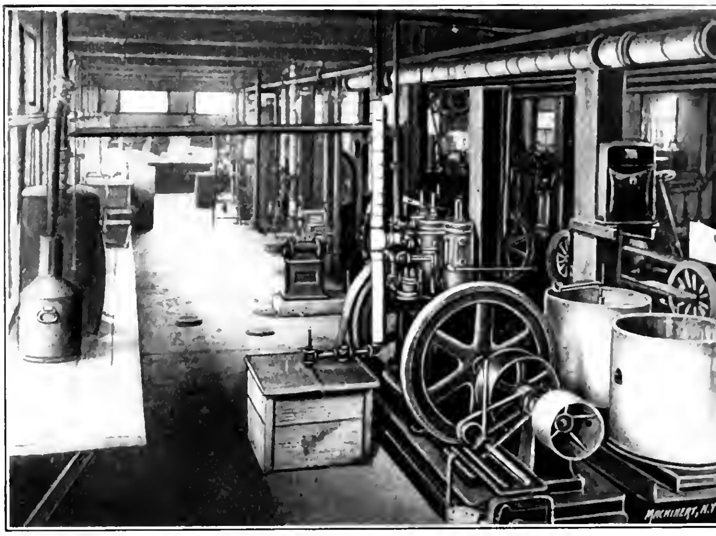


Fig. 2. General View of Laboratory.

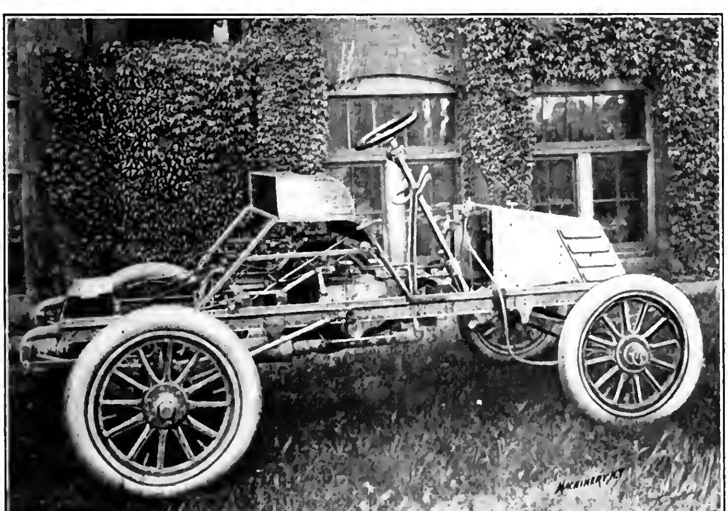


Fig. 3. Winton Chassis fitted for Road Test

The boiler room adjoins the laboratory on the north and at present contains five boilers aggregating about 450 horse power. There are representatives of the horizontal fire tube and of the Babcock & Wilcox, Heine and Stirling water tube types; one of the boilers is equipped with a superheater and with induced draft. The Brightman, Babcock & Wilcox, Murphy, and Jones underfeed stokers are in use, and coal is handled by a traveling bucket with overhead trolley.

A duplicate system of steam piping is used and there is a modern equipment of pumps, injectors, feed-water heaters and feed regulators. A system of galleries and ladders gives access to every part of the boilers for experimental work. Either saturated or superheated steam can be delivered to the laboratory and at any pressure up to 200 pounds.

In the laboratory is a special pump and feed-water heater equipped with measuring tanks and meters for use in testing the boilers, and these are entirely independent of the pumps and heaters used in daily work.

The laboratory proper consists of one large room unobstructed by partitions and having entrances at either end. Along the south and west sides run hardwood benches three feet from the floor, adapted for light experimental work and fitted with numerous steam and water connections.

The apparatus for calibration of indicators, gages and thermometers is on these benches. An Ingersoll-Sergeant compound, two-stage, air compressor, with air cylinders 12 and 18 by 12 inches, is used particularly for indicator work and for thermodynamic experiments on air and steam. The Porter-Allen engine, so piped as to be driven by steam or compressed air and equipped with an Alden brake, is also convenient for thermal and mechanical efficiency tests.

Two small steam engines are used for practice in valve setting and governor adjustment. One of them has a special attachment for measuring friction of steam packings. A Fairbanks-Morse single-cylinder, four-cycle gas engine and a Westinghouse two-cylinder gas engine afford opportunity for the study of gas and gasoline as motive powers. The Westinghouse engine is provided with gas and air meters and with apparatus for measuring the temperatures of the jacket water and the exhaust gases. Both engines are fitted with brakes and indicator motions. A tuning fork chronograph on the Westinghouse engine has made possible some very inter-

esting experiments on the fluctuations of speed during each revolution.

An Arctic ice machine of five tons' capacity, with compressor, condensing coils and brine tank complete, is equipped with special measuring apparatus and furnishes an excellent opportunity for research work in this very interesting field. The determination of the mechanical and thermal equivalents of a "ton of refrigeration" is a problem which can be worked out accurately with this apparatus.

Two small steam turbines, a 15 horse power De Laval and a 25 horse power Dow machine have been installed for high speed tests. Experimental work on the bursting strength of turbine disks is now under way.

The work which has already been done on flywheels, wooden pulleys and emery wheels has heretofore been noticed in these columns. A Winton gasoline motor car, the gift of the company, is used for efficiency tests. The machine is stripped of its upper works to make it accessible for experimental work and has a special form of water-cooled brake to measure the power developed. On the upper floor has been built a rolling track, similar to those used for locomotive testing, so that

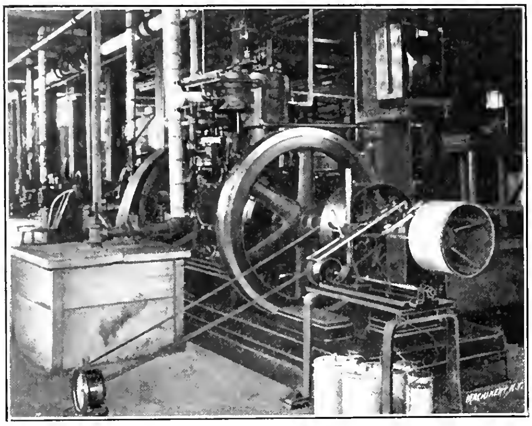


Fig. 4. Testing Westinghouse Gas Engine with Tuning Fork Chronograph.

automobiles may be run at full speed under road conditions and suitable measurements made of the horse power and the draw-bar pull.

The piping in the laboratory is rather complicated, as it must accommodate live and exhaust steam, hot and cold water, compressed air, coal gas and ammonia. All of the piping is overhead, the cross mains running between the floor beams above while the long mains run under the beams, so that there is no interference A comprehensive color scheme is used in painting the pipes so as to differentiate the various fluids carried. The student soon learns that a blue pipe is cold and a yellow one hot and rarely confuses gas with steam or air.

Double steam mains accommodate saturated and superheated steam, while a duplicate system of exhaust piping makes it possible to run the engines condensing or non-condensing by the turn of a valve. The condensing main connects with a Wheeler surface condenser fitted with an independent air pump. Two additions to the equipment will probably be made within a few months: a 125 K. W. electrical unit, a high-speed engine and generator adapted to furnish power and lights on a three-wire system; and a 50 K. W. unit with an engine of the Corliss type for use as a reserve.

The laboratory training begins with indicator practice and the calibration of instruments followed by calorimeter and injector tests. The students take turns in running the various engines under the instruction of the engineer until they can be trusted to start up and run any machine alone. Each student has a week's practice in the boiler room where he learns the methods of firing the various boilers and stokers and the manipulation of the accessory machinery.

By the time the learner has progressed to the efficiency experiments and the commercial testing of the steam, gas or refrigerating plants he is able to run each plant and understand its operation.

MILLING MACHINE FIXTURES.—4.

E. R. MARKHAM.

Vertical Spindle Milling.—When surfaces are to be machined flat it will be found more satisfactory and quicker, in many cases, to use an end mill of the proper design. The work may be held in a special vise or in an ordinary vise attached to the vertical face of an angle iron and done in an ordinary horizontal milling machine as indicated in Fig. 40.

The best results in vertical milling are obtained by using a vertical spindle milling machine, especially if heavy cuts are to be taken; but unless there is work enough to keep the vertical machine busy it is, generally speaking, advisable to buy a horizontal machine with a vertical attachment, since it is

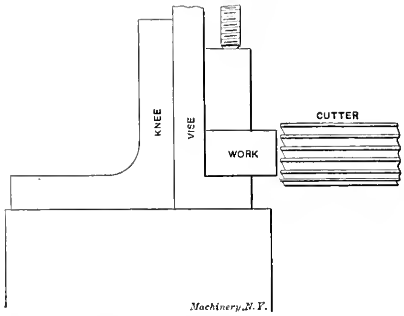


Fig 40. Using the End Mill on a Horizontal Machine.

possible to use the machine either way, as required. The fixtures for holding work when machining by this method will not differ materially from those already described. Fig. 41 represents a piece of work being machined by means of a vertical spindle attachment, the cutter being an end mill with inserted blades, cutting a block of 60 point carbon open hearth steel for a die block used in a drop hammer for drop forging work. These blocks were formerly planed but it is found possible to produce them much cheaper by milling.

Cams are applied to vises and special fixtures in a variety of ways and furnish a rapid means of binding the work in place. At times the cam is very simple, being on the end of a piece as shown in Fig. 42. If it is necessary to get considerable length of movement to the slide of fixture the cam may be made on a piece having a turned projection on its lower surface which fits in a hole in the base of the fixture. When it has been

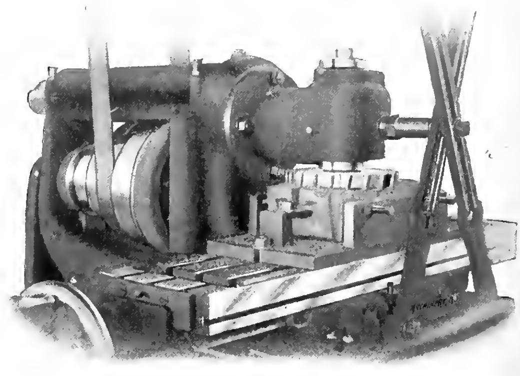


Fig. 41. The Vertical Milling Attachment.

turned sufficiently to relieve the pressure against the slide the cam may be lifted from the fixture and the slide moved as much as is necessary. After placing another piece of work in the fixture the slide may be moved against it, the projection on the cam inserted in the hole, and the necessary pressure applied by turning the cam.

Figure 43 shows a cam which is round in form and has a round projection which enters a hole in the fixture. This smaller projection is eccentric with the larger in which a hole is drilled and a lever inserted as shown. This, like the previous form, may be removable if desired. Cams of various

designs may be employed for holding work, the particular design depending on the piece to be held.

Binding Devices.—The method employed for holding work in the fixture depends of course on the nature of the work. Unless it is necessary to bind the work more securely than would be possible with a cam, it is not advisable to use a screw on account of the length of time wasted in turning it back and forth sufficiently to secure or free the work.

At times it is *necessary* to use a screw and it is found possible to save time by the use of a collar of the description shown in Figure 44. When the screw is turned back part of a turn the slotted collar may be removed and the work taken

FIG.42

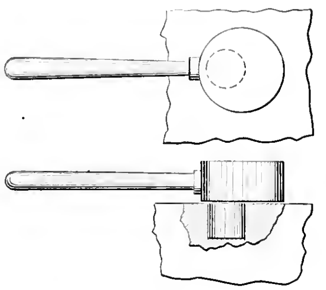


FIG.43
Cam Devices for Holding Work.

out. After putting another piece in the fixture the collar is placed on the screw *under* the head, and the screw tightened to give the desired effect.

Figure 46 shows a method, some modification of which may be employed to hold work when it would not do to have any screw heads or other devices projecting above the strap. When pressure is applied by means of the screw the portion *a* is forced down onto the piece of work. The angle piece is hinged at *b* as shown. At times it is possible to substitute a cam for the screw and so lessen the time necessary to operate the device.

When forgings or castings are machined it is sometimes possible to take advantage of the beveled portions occasioned by the draft necessary to get the forging out of the die, or the pattern from the mold. If the amount of bevel ordinarily given is not ample to insure desired results a sufficient amount may be given when the die for the forging or the pattern is made. Figure 47 shows a fixture holding a casting by means of the beveled edges referred to.

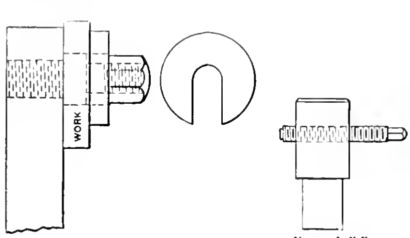


Fig. 44. Fig. 45.
The Slotted Collar and Removable Post.

When such a method would bind the work sufficiently strong it is customary many times to use a screw having a right-hand thread on one end and a left-hand thread on the opposite end. Two applications of this principle are shown in Figure 48; at *A* the screw is held from moving lengthwise by means of the block *c* and the jaws are moved toward or away from each other by turning the screw. The jaw at the left, *a*, has a right-hand thread while the right-hand jaw, *b*, has a left-hand thread. This fixture is valuable when it is desirable to mill a slot, or a projection in the center of pieces which vary in width, and where the variation is immaterial. In the fixture *B* the jaw *a* is tapped with a left-hand thread and the stationary upright, *b*, with a right-hand thread. These threads being square in form may be of coarse pitch, thus causing the slide to move rapidly.

To save time it is customary at times to locate the binding screw in a removable post as shown in figure 45. When removing the work from the fixture the screw is turned sufficiently to relieve the pressure and the post lifted out of the

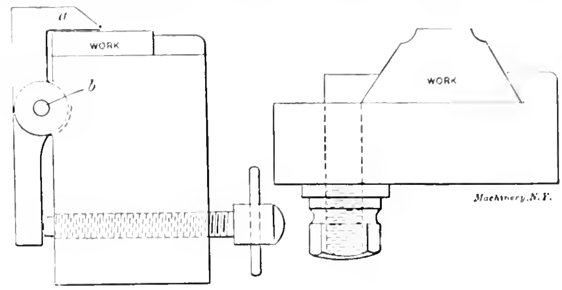


Fig. 46. Fig. 47.
Holding the Work where Head Room is Scant

hole, after which the work is removed from the fixture, the bearing surfaces cleaned, another piece put in place, the post again put in the hole and a partial turn of the screw binds it securely. In many instances if a screw were used in a stud securely fastened to the fixture it might be necessary to give it ten or a dozen turns before the work could be removed.

Figure 49 represents a device used for holding two pieces of work to be machined at the same time. Each piece rests against stationary portions *a a* of fixture, and is held in place by the swinging pieces *b b*, which are hinged at the center as shown, and are closed onto the work by means of the pointed screw *c* which passes through the stud *d*. This stud can turn in the hole in the fixture and so allow the point of the screw to swing somewhat to conform to any variation in the thickness of the pieces being held.

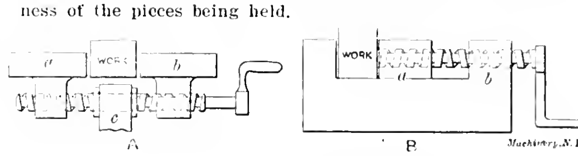


Fig. 48. The Differential Screw Movement.

When pieces have holes through them it is possible many times to take advantage of these in holding the work. Figure 50 represents a piece of work having on its upper portion a counterbored hole. A pin with a head a trifle smaller than the counterbored portion of hole extends down through the hole and through a hole in the fixture as shown. In the small end of the pin is a rectangular hole. Through this is driven a wedge-shaped key which draws the work solidly onto the seating surface of the fixture.

There are occasions when an ordinary cam would be objectionable and a screw would be too slow, and yet a combination of the two works nicely. Figure 51 represents such a binding device, and was used in holding a blank for a spring

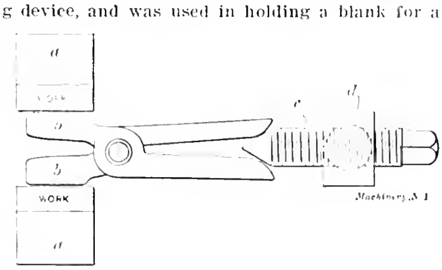


Fig. 49 Holding two Pieces of Work at a Time

bow for a machinist's caliper while the ends were bent in a punch press. When the screw is turned down into the threaded hole in the base, the V-shaped projection under the head passing up the incline on upper portion of leaf forces it down onto the blank. When the projection on the screw reaches the flat portion at the top of the incline, the leaf has forced the blank down solidly to the bending fixture. If the

screw is turned more it, of course, continues to descend and draw the leaf down still more. The advantage of this combination is that if a cam does not pass around to a point at the end of the throw, it is apt to jar loose if subjected to vibration, whereas the projection under screw head passing up the incline acts as a cam, when it rests on the flat portion and continues to draw the leaf down as the screw goes into the

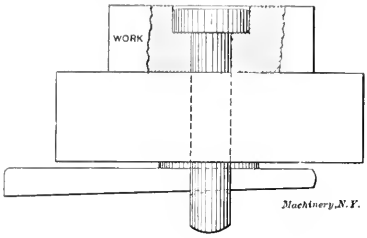


Fig. 50. Holding Work from below by a Counterbored Hole.

tapped hole. Although I have taken a fixture used on a punch press to illustrate an idea, I have applied the same holding device to fixtures for use on milling machines, but they were of such complicated design that it would appear to be folly to attempt to use any of them in illustrating this simple device.

I find that I have taken up a topic that might be enlarged upon, and articles written that would take up more space than would be wise to assign to any one subject.

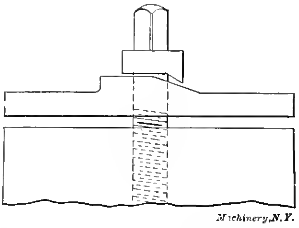


Fig. 51. A Combined Cam and Screw Clamp.

I have attempted to outline the fundamental principles, and to illustrate by means of simple fixtures and various forms of binding devices. The application must, of course, be left to the individual designer who should always bear in mind that simplicity is always preferable to elaboration, provided the simple thing insures the desired result.

* * *

Some one has figured out that if a college athlete could jump as far in proportion to his weight as the ordinary flea he could cover a distance of 1,100 feet at one leap, instead of say 25 feet at the most. We have not verified these figures and do not know whether they are susceptible of verification but would say that if a man were able to jump 1,100 feet his body would have to be made of something stronger than steel in order to stand the shock of striking the ground. If an ordinary man of average weight should jump 1,100 feet the shock would be so tremendous that his entire body would be reduced to pulp. The fact that the force of gravity is accumulative makes it quite improbable that a race of great giants ever existed, and by mere reasoning we can dispose of the fairy tales of men who were 100 feet or more high. If we can conceive of a man 60 feet high, for example, we must admit that he would weigh about 1,000 times as much as the average six-footer, if built in the same proportion. With this tremendous height an ordinary stumble, which would throw such a giant prostrate, would mean that his head would fall through a distance of 60 feet and it is not conceivable that any object of flesh and bone could stand such a shock without disorganization.

* * *

There is preserved at Barre, Vt., a surveyor's compass which may be the first ever made in America. It was built by Peregrine White, who was born on the Mayflower as the vessel lay off the coast waiting for a chance to make a landing. The compass is incased in hand-hammered brass, and the needle is said to point as true to-day as in the day of its maker.

THE HISTORY OF THE MARINE TURBINE.

FROM THE TURBINIA OF 1894 TO THE CARMANIA OF 1905.

The recent placing of the trans-Atlantic turbine steamer *Carmania* in commission and the successful completion of her first voyage on December 11 makes it of interest to review at this time the important work that has been done in the development of the marine steam turbine. Most of the turbines applied to the propulsion of vessels have been of the Parsons type, although some work of this character has been done both by Rateau and Curtis. In 1894 the Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne, England, was formed and the experimental boat *Turbinia* constructed. Her dimensions were 100 feet beam, 3 feet draught and 44 tons displacement. She was fitted with engines of 2,000 horse power with an expansive ratio of 150. There were three separate turbines —a high-, an intermediate-, and a low-pressure, each driving a screw shaft and on each shaft were keyed three propellers of small diameter. She attained a speed of over 34 knots and in 1896 tests made by Prof. Ewing, fifteen months after the vessel was completed, showed that the turbines had lost nothing in efficiency during that interval of time.

Various other high speed boats were built during the next five or six years which have been fully described in technical journals. Two of these, the *Viper* and *Cobra*, high speed torpedo boat destroyers, were unfortunately lost at sea and turbine propulsion received a serious setback. An organization was finally effected, however, which included the shipbuilding firm of Messrs. Denny, the Hon. Charles A. Parsons and Capt. John Williamson, which resulted in the first turbine steamer, *King Edward*, in 1901, for service on the Clyde.

The *King Edward* is a boat 250 feet long, 30 feet beam with 6 feet draft. The arrangement of the machinery is practically the same as has been used in all the more recent vessels, including the ocean liners, fitted with Parsons turbines. There are three separate turbines driving three screw shafts. The high-pressure turbine is placed on the center shaft and the two low-pressure turbines each drive one of the outer shafts. Inside the exhaust ends of each of the latter are placed the two astern turbines which rotate as one piece with the low pressure motors and when in operation reverse the direction of rotation of the low-pressure motors and outside shafts.

In ordinary going ahead steam from the boilers is admitted to the high-pressure turbine and after expanding about 5 times passes to the low-pressure turbines and is again expanded in them about 25 times and then passes to the condensers, the total expansion ratio being about 125 as compared with from 8 to 16 usual in triple expansion reciprocating engines of the marine type. At 20 knots the speed of the center shaft is 700 and of the two outer shafts 1,000 per minute.

When maneuvering in or out of harbor the outer shafts only are used and the steam is admitted by suitable valves directly into the low-pressure motors or into the reversing motors, for going ahead or astern. The high-pressure turbine under these circumstances revolves idly, its steam admission valve being closed and its connection with the low-pressure turbines being also closed by non-return valves.

This vessel met with success on the Clyde and her turbines are stated to have required no expenditure for maintenance and to have deteriorated in no way during five years of service. Mr. James Denny, one of her builders, estimated that the coal consumed was about 20 per cent less than if she had been fitted with reciprocating engines and paddle wheels.

In 1902 the *Queen Alexandria* was built for Clyde service. She differed from the *King Edward* in being slightly larger and in having more efficient reversing turbines. This boat formed the subject of a short report by Commander Walter F. Worthington, U. S. Navy, who writes as follows:

"Her owners have stated that the coal consumption is much less than that of a similar vessel fitted with triple-expansion engines, which they previously operated on the same service. The oil consumption is almost nothing, as the same oil is used over and over again; the total loss in three summers of about eighteen months' running having been but one gallon.

"The shafts, when carefully gaged, showed a wear of only

1/1000 of an inch the first summer and nothing the second summer. The tool marks still remain in the thrust collars. Metallic packing is used for all stuffing boxes. The stopping, backing and maneuvering of the engines was done quite as quickly and easily as could have been done with triple-expansion engines, all of the signals being answered promptly. The vacuum being constant, the speed called for was determined by the pressure shown on the gage attached to the H. P. valve

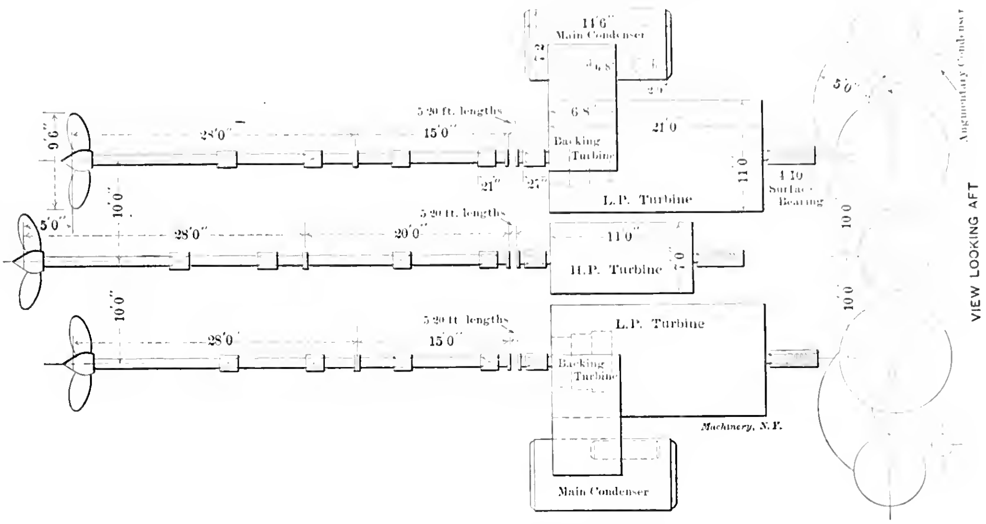


Fig. 1. Arrangement of Turbine and Propellers of the Atlantic Liners "Victorian" and "Virginian."

chest, so that when, at any time, the captain signalled "half speed," for example, he always got the same number of revolutions and there was no delay or mistake due to attempting to count revolutions. The engines were run entirely by the pressures indicated on the gages. A dial and pointer were connected with each main engine shaft so that the direction and speed of the shaft could be observed if desired. In fact, that was the only way that one standing a short distance from the engines could know whether or not the engines were in use, as they made no noise whatever, and there was no sound of rushing steam, such as is heard in other engines."

In the *London Times* for Dec. 13, 1905, is an article by Mr. Parsons upon the history of the marine turbine from which the following statement of the more recent developments is taken in part:

The successful results of the *King Edward* and *Queen Alexandria* paved the way for the long list of similar turbine vessels, the cross-Channel boats commencing with the *Queen*, for the South-Eastern and Chatham Railway Company, plying between Dover and Calais, of which class of vessel 12 are now on service and six are building. Of these several vessels, we have the *Queen* carrying passengers from Dover to Calais at two knots greater speed and with 25 per cent less coal per passenger than any other vessel on the line, while the *Invicta* and the *Onward* turbine boats have since been added to the fleet with results surpassing those of the Queen. Again in 1904, on the Heysham Line to Ireland, the *Londonderry* and the *Manxman* turbine vessels beat their sister twin-screw vessels *Donegal* and *Antrim*, propelled with triple expansion reciprocating engines, by one knot, and lastly the *Viking*, built by Messrs. Armstrong, Whitworth & Co., plying from Liverpool to the Isle of Man, has consumed during the season exactly 25 per cent less coal per knot and is nearly two knots faster than any other vessel on this line.

About this time the third-class turbine cruiser *Amethyst* was built for the British Admiralty. She is 360 feet in length and of 3,000 tons displacement. Three other engine-driven cruisers of the same size were built simultaneously, one of which, the *Topaz*, was selected for a series of competitive trials with the *Amethyst*.

The contract speed of the vessels was 21¾ knots, and the results showed that at all speeds above 14½ knots the turbine vessel was the more economical, at 18 knots the turbine was 15 per cent more economical, at 20½ knots 31 per cent, at 22.1 knots 36 per cent, and at full power in each vessel the *Amethyst* showed 42 per cent more power than required by contract on the coal allowed; while the *Amethyst* reached 23.6 knots on the specified coal and the *Topaz* only 22.1 knots. In other words, the *Amethyst* has a radius of action at 20 knots speed of 3,600 nautical miles, while her sister vessels with ordinary engines can only steam 2,000 miles at the same speed.

Atlantic Liners Fitted with Turbines.

Next we come to the Atlantic liners. The Allan liners *Virginian* and *Victorian* started to ply between Liverpool and Canada in the summer of 1905.

In April, 1905, Commander A. D. Canaga, United States Navy, was detailed to make the trip to Europe and return on the turbine steamer *Victorian* and report the results of his observation to the department.* There, unfortunately, is no similar vessel of the same line propelled by reciprocating engines with which a direct comparison can be made, but certain points brought out by Commander Canaga will be of interest. Figs. 1, 2 and 3 are reproduced from his report showing the arrangement of turbines in this vessel which is like that usually adopted for the Parsons' apparatus, and is practically the same as already described in connection with the *King Edward*. The steam from the boilers is led into the engine room through two 12-inch pipes uniting in the throttle valve at the working platform. From the throttle valve steam is lead through two 12-inch pipes to the high-pressure turbine.

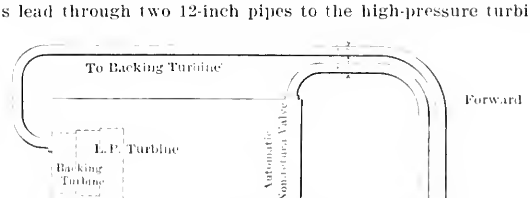


Fig. 2. Showing Pipe Connections of Turbines

When in free route the steam is passed through the high-pressure turbine where it spreads, half going to the starboard and half to the port turbine through the receiver pipes, and thence through exhaust pipes to the main condensers. In maneuvering, the main throttle is closed and steam admitted to the maneuvering valves, Fig. 3, one for each low-pressure turbine. These are simple slide valves which when placed at the upper

* Journal American Society of Naval Engineers, August, 1905.

end of their stroke admit live steam to the forward end of the low pressure turbine, when at the bottom of their stroke admit live steam to the backing turbine, and when in mid-position shut the steam from both the ahead and backing turbines.

To prevent the steam blowing off into the high-pressure turbine when maneuvering, non-return valves are fitted in the receiver pipes between the high-pressure and low-pressure turbines, as shown in Fig. 2. These valves are automatic opening or closing as the live steam is admitted to the high-pressure or low-pressure turbines.

At the forward end of each turbine shaft is fitted a safety governor which in case of accident closes the main throttle valve. These governors serve another purpose, also, by indicating whether the turbines are at rest or in motion, since from the working platform they are the only visible moving parts. The Commander reports that the turbines are easily and quickly handled and that the minor mishaps and annoyances met with in reciprocating engines are absent. He notes a pleasing absence of vibration and of racing in high seas. Against this immunity from racing, however, must be set the lack of holding power of the small screws with which turbine vessels must be equipped. It was observed that the influence of head winds and heavy seas reduced the vessel's speed considerably more than would have been the case with the large propellers used with reciprocating engines.

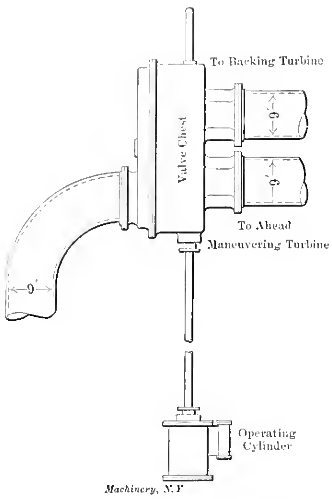


Fig. 3. Arrangement of Operating Valve.

Attention is called to the fact that heating of bearings is a more serious matter with turbine machinery than with reciprocating engines as any unusual wear would cause interference between the rotating and stationary blades and on one of the trips the Victorian was delayed about 29 hours owing to some grit that got into one of the bearings and necessitated overhauling, after which, however, there was no trouble. There was also considerable difficulty from priming of the boilers but with consequences less serious than in the case of reciprocating engines.

The extension of turbine propulsion to still larger Atlantic lines was a question that early engaged the attention of the Cunard company and a committee of investigation was appointed, composed of representatives from the Admiralty, Lloyd's, and the leading shipbuilding and engineering firms and naval architects of England whose thorough investigation of the subject resulted in the recommendation of turbines for the large express Cunarders of 60,000 to 70,000 indicated horse power, and also for the Cunard liner *Carmania*, of 20,000 tons and 23,000 I.H.P., which has just been placed in service.

The investigations of the Cunard Committee comprised comparative tests on land of large turbines driving dynamos with similar reciprocating plants at various rates of output; they also included comparative trials of the turbine vessel *Brighton* with the reciprocating-engined twin-screw vessel *Arundel* between Newhaven and Dieppe; the two vessels were run abreast, and the consumption of water taken in each vessel on both voyages, and in these trials the turbine easily beat the triple-expansion engine in economy of steaming.

Comparison between Turbines and Reciprocating Engines

The best opportunity for comparing the performance of vessels fitted with turbines and engines has been afforded by the Midland Railway Company's four boats of the Heysham Line mentioned above. Of these, the *Londonderry* and *Manxman* have turbines and the *Antrim* and *Donegal* reciprocating engines. The *Londonderry*, *Antrim* and *Donegal* have the following dimensions: Length 330 feet, breadth 42 feet, depth 25 feet, 6 inches. The *Manxman* is of the same length and depth, but has a breadth of 43 feet. The turbine boat *Londonderry* carries 150 pounds boiler pressure and the others 200 pounds pressure. The engines of the *Antrim* and *Donegal* are of the triple-expansion type, differing only in details, and drive a single, three-bladed propeller. The turbines of the *Manxman* were designed for 25 per cent more power than those of the *Londonderry*, but are of similar construction and drive three three-bladed screws after the usual manner. All the boats have high-grade condensing apparatus, but the *Manxman* has in addition a Parsons vacuum augmenter, for producing a high vacuum.

The results of the officials trials showed the two boats with reciprocating engines to be on a par in economy and to use practically the same amount of feed water under like conditions. At speeds of 19 to 20 knots, however, which is the working speed of all the vessels in service, the water consumption of the turbine steamer *Londonderry* was 8 per cent less and of the *Manxman* 14 per cent less than of the *Antrim* and *Donegal*, while throughout a speed range from 1 to 20 knots the turbine boats showed superior economy. Speed trials were run between the two turbine boats and the *Antrim* and the *Londonderry* proved about one knot faster and the *Manxman* from one to two knots faster than the *Antrim*, under like conditions.

Later, comparisons were instituted between the turbine steamers and those with reciprocating engines, based on the log books in which the daily records were kept while the boats were in regular service. During a part of this comparative period the *Manxman* was not on the same route as the other vessels so that she could not be consistently compared with the *Antrim* and *Donegal* during the entire time. Also, the high-pressure turbine of the *Londonderry* was partially wrecked owing to the blades of the rotating drum coming in contact with the stationary blades so that the records from this steamer were interrupted for three months. Valuable comparative figures were secured, however, and are summarized in table below. The regular route was between Heysham and Belfast, one vessel plying each way every night except Sunday. The comparisons are made in each case between vessels running in opposite directions on the same days and the table gives the weight of coal each vessel consumed on a given number of trips, exclusive of that burned when in port, which of course does not affect the performance of the propelling machinery.

TABLE SHOWING RESULTS OBTAINED BY STEAMERS RUNNING SIMULTANEOUSLY, BUT IN OPPOSITE DIRECTIONS.

	Reciprocating Engines.	Turbines.
	Antrim.	Londonderry.
Number of Trips	48	48
Average Coal per Trip, tons	35.6	35.3
" Speed in knots	19.7	19.5
	Donegal	Londonderry.
Number of Trips	42	42
Average Coal per Trip, tons	36	36.9
" Speed in knots	19.2	19.8
	Antrim.	Manxman.
Number of Trips	29	29
Average Coal per Trip, tons	38.6	38.6
" Speed in knots	19.5	20.3
	Donegal.	Manxman.
Number of Trips	39	39
Average Coal per Trip, tons	38.7	40.2
" Speed in knots	19.3	20.3

REPRESENTATIVE AMERICAN MECHANICS.

BAXTER D. WHITNEY.

Baxter D. Whitney, the oldest manufacturer of woodworking machinery in America, was born in Winchendon, Mass., June 28, 1817. His father was a woollen manufacturer and in his childhood he spent much of his time in his father's mill. After attending school in his home town, with supplementary terms at Hancock, N. H., and Fitchburg, Mass., he went permanently into the shop to work for his father as a repair "man." While still a boy, the mill was having two cassimere looms made at the White & Boyden Machine Shop in Worcester, but so much difficulty was experienced in finding machinists capable of doing the work necessary on them, that the builders made very slow progress in filling the order. The elder Whitney, in order to help matters along, was asked to furnish a machinist to work on the looms, and the boy of thirteen was sent down to Worcester to do the work of a journeyman machinist. Having always worked for his father up to this time, he was naturally quite independent in his ways, and working for a stranger was new and rather puzzling to him. He relates with some amusement how he was given the job of polishing a number of cranks on a wooden wheel covered with emery. After he had finished the first one in good shape, he laid the job aside and started on something else, telling one of the proprietors when he came around to inquire into the matter, that he couldn't do them, there were "too many of them." There were probably ten or a dozen in the lot. After a little explanation on the part of the older man, however, the boy began to realize that it was sometimes necessary to keep at work even when the job was more or less monotonous. His wages at that time were $13 per month and board, Mr. White furnishing the board at his own house.

On his return to Winchendon, he again went to work for his father, doing all the repair work of the mill and building some new machinery. He gradually, however, drifted into business for himself, hiring space and power in a nearby shop and employing more or less workmen as conditions warranted. The books of the firm show that in 1835 there were twenty-nine men on the pay-roll. As time went on, he gradually left off working for his father and finally gave his full attention to his own business. The first machines which he made were those used in the manufacture of woollen cloth. Among them were a machine for cleaning the flocks out of teazels, a number of "steam jigs" and sixteen power looms, these last being built when he was twenty years old.

The town of Winchendon, which is situated at an elevation of about 1,100 feet in the hill district of central Massachusetts, was surrounded by dense forests of valuable timber, so Mr. Whitney's thoughts naturally turned toward the construction and improvement of machinery for working lumber into its various useful forms. Some of the early machinery he built was used in the manufacture of tubs and pails, a branch in which the firm has steadily kept a prominent position. A short time later he began to study on the cylindrical planer problem, and finally built a successful machine which was sold to a local firm. Cylindrical planers had been built before this time, but in none of them was it possible to plane a board without clipping the ends. In this first machine this was avoided by tipping up the front and back ends of the table and thus forcing the stock to bend in its passage through the machine, so keeping the ends down flat on the bed when entering and leaving the sphere of action of the knives. This arrangement is now, of course, obsolete, the "pressure bar," which is a feature of the present Whitney planer not having been invented until some time later. The old machine was used for a great many years, and is still preserved in one of the store rooms of the shop at Winchendon.

This wood working machinery, which was first built to meet local demands, soon began to attract attention from other sections of the country and orders came in more and more rapidly. Along in the middle of the forties Mr. Whitney determined to build a new shop for himself and go into business on a larger scale. Accordingly in 1845 he bought a water privilege near the center of the town and built the stone dam, fore-bay, etc., on the site of the ones which are now used for furnishing power for running the machine shop and lighting the town. In August of the same year his foundry was completed and iron melted, and the shop buildings finished so that by the end of the year the plant was in running order. Practically all of the machinery in this shop was home made. It was comprised principally of lathes, a drill press, and a planer with a platen about 36 feet long. The way in which the bed of this planer was levelled is interesting. Two long stringers built up of plank were laid down; to these were fastened the ways made in V-shape and cast in sections of about 8 feet long each. These ways were milled in a crude machine. The rough casting was fastened to a carefully straightened wooden plank which was free to slide in timber ways also carefully straightened and leveled. The milling cutter was mounted on a revolving arbor above the work, and the casting was fed against the formed cutter by a weight feed. The Cheshire Railroad was being built through the town at about this time and Mr. Whitney engaged the engineer in charge to level the ways of his planer for him, this being done with a level and rod in a way which suggests the methods now used by some firms in setting up work on the floorplate. After the stringers had been leveled as carefully as possible, the ways were bolted to them and these in turn were tested. At short intervals the top of the way was filed off until the surveyors' instruments showed all the spots to be parallel to the base line. After each side had been spotted in this manner, the ways were filed to a gage to bring the whole surface down even with the spots. Mr. Whitney relates that, desiring to test the accuracy of the engineer's work, he had him go over the job again after the filing was completed. He held the rod himself and at one point inserted under it a very thin pine shaving; the engineer made him stop, took a second sight, and remarked that he thought the casting was "just a little mite high." Mr. Whitney concluded that the job was reasonably well done. The table of this planer was driven by a rack and pinion, being different in that respect from most of the early machines, which received their motion from the winding and unwinding of a chain upon a drum.

From this time on the business rapidly grew in size and in reputation, improvements being made in their product constantly from year to year. Among the most notable of Mr. Whitney's contributions to the art of woodworking are his development of the cylinder planer, the invention of the gauge lathe, and the wood scraping machine. These machines were exhibited at a number of expositions in Europe and aroused a great deal of interest wherever they were shown, so much so that Mr. Whitney found in later expositions exact duplicates of his earlier machines being exhibited by European manufacturers. Up to within a few years ago, when Mr. Whitney was seized by a serious illness, he personally managed the business of the firm. Since that time he has, however, retired from active management and gives his entire time to preserving his health and vigor, and enjoying life in general. But, as may be imagined, a large part of his enjoyment in life is

still wrapped up in the business which he had fathered for so many years, so he is often to be found about the shop, watching the progress of the work, and interesting himself in the various improvements that are being made from day to day. So confirmed has this habit of improvement become in this establishment that a visitor will see very little to remind him that the business is seventy or more years old.

* * *

THE DISCUSSION ON BEARINGS HELD AT THE DECEMBER MEETING OF THE A. S. M. E.

The discussion on bearings at the fall meeting of the A. S. M. E. brought together a large amount of valuable information on cylindrical and thrust bearings of the sliding, roller, and ball designs, and included discussions on the limits of pressure and speed, lubrication, thickness of oil film, cooling, and materials. Some of the important points covered are reviewed in the following paragraphs.

Sliding Bearings.

A number of contributions were made descriptive of the practice of builders of various types of machinery. Mr. P. H. Been described the type of bearing used by a prominent Corliss engine builder. In proportioning the bearing the dead weight only of the parts supported is considered; that is to say, the weight of the shaft, flywheel, crank, connecting rod, etc., for a horizontal engine, and, in addition, the remaining reciprocating parts for a vertical engine. The pressure of the steam, presumably on account of its intermittent character, was not considered. Putting the general practice in the form suggested by Prof. Thurston a number of years ago, the product of the total pressure multiplied by the projected area of each journal would probably range between 60,000 and 78,000. One hundred and forty pounds per square inch is considered to be about the limit for unit pressure.

For shafts of ordinary size the bore of the bearing is made about 1-64 large. The castings are sometimes cored to allow the use of circulating water to prevent overheating, but where this provision is made it has been found in practice that its use is seldom necessary. The usual bearing material is babbitt, covering the entire bore and cast into dovetails and well hammered before being finished to size. A later method of lubrication is the system of flooding the bearings from a tank having a few feet head. By this method the oil is used over and over again and there seems to be rather less waste than when the oil is fed drop by drop. In the case of a 22 and 42 x 42 compound tandem Corliss engine connected to a generator, running at 100 revolutions per minute, 50 gallons of oil per day passed over the main outward bearings, using this method of lubrication. The day's run amounted to twenty hours; with the room at 92 degrees, the temperature of the bearings was constant at about 124 degrees.

Mr. George M. Basford gave some information relating to current practice in locomotive design. The conditions under which the locomotive works are so varying and so subject to incidental influences that it is practically impossible to approach the problem of bearing design from a purely analytical standpoint. If under severe working strains the unit pressure of any part of a journal box becomes so high that the oil is forced out from between the bearing surfaces, and the two metals come in contact, a hot box will result. General practice has agreed upon the following figures as giving reasonably satisfactory results.

TABLE 1. SAFE PRESSURES FOR LOCOMOTIVE BEARINGS,

Location of Bearing.	Lbs. per sq. in. of Developed Area.	Nature of Service.
Crank Pin..........	1,500 to 1,700	Lubrication easy.
Wrist Pin...........	4,000	Rotation incomplete and intermittent.
Pass. Loco. Main	190	Lubrication difficult.
Freight Loco. Main .	200	" "
Switch Loco. Main ..	220	" "
Car and Tender......	300 to 325	Must be designed also to give safe fiber stress as a cantilever.

These figures are not ironclad, but are always subject to the judgment of the designer.

Mr. George R. Henderson called attention to the effect of applying the load to a journal box eccentrically; there is an especial temptation to do this in locomotive design, since the gage of the track and consequently the distance between the hubs of the driving and truck wheels limits the extreme length possible over the bearings.

Let P equal the load; d the diameter of the journal; l its length, and p the unit pressure. Then will

$$p = \frac{P}{d\,l}$$

Supposing a driving journal to have been originally 10 inches in length and the diameter of the journal 8 inches. If the load is 16,000 pounds, uniformly distributed, the pressure would then be 200 pounds per square inch.

$$p = \frac{16{,}000}{8 \times 10} = 200.$$

Supposing the designer, to reduce this unit pressure, makes the journal 2 inches longer, but is not at the same time able to move the bearing on the spring rigging to a central position. If this, as in the first case, was still 5 inches from the outside edge, it would bear an inch away from the center line of the journal. Denote this eccentricity by the letter x, then will

$$x = 1.$$

Under these conditions the unit pressure at either edge of the box may be expressed thus:

$$p' = \frac{P}{d\,l} \pm \frac{P\,x}{\frac{1}{6}\,d\,l^2} = \frac{P}{d\,l}\left(1 \pm \frac{6\,x}{l}\right)$$

The positive sign refers to the edge nearest the load and the negative to the furthest edge. When the box is 12 inches long with the data previously given, this equation will figure out as follows:

$$p' = \frac{16{,}000}{8 \times 12}\left(1 \pm \frac{6}{12}\right) = 166\left(1 \pm \frac{1}{2}\right) = 249 \text{ or } 83$$

The larger value is the unit pressure at the outside edge and the smaller value that for the inside edge of the bearing. Thus, while the average pressure is only 166 pounds per square inch the lengthening of the box and the consequent eccentricity of the loading has increased the maximum pressure to 25 per cent more than with a journal 10 inches long and a central load. This might be so great as to prevent proper lubrication of the bearings at this point under running conditions. It is, then, generally preferable to get along with an increased unit pressure, rather than to create a condition of eccentric loading.

Mr. Joseph J. White described the box shown in Fig. 1, which was designed to meet the conditions necessary for a successful high-speed bearing for use on woodworking machinery. In a box held down by four bolts, according to the usual practice for such machinery, it is impossible to get a uniform pressure on the journal. By screwing the bolts down in turn a little at a time and then revolving the shaft to see if it runs freely, and easing up or tightening down until it appears to be all right, an approximately satisfactory adjustment may be obtained. If, however, this adjustment be made at all carelessly, the unit pressure near one of the bolts may be sufficient to break through the film of oil and bring the two bare metals into contact. In the box described by Mr. White and shown in Fig. 9, the cap, instead of being held down onto the journal, is tightened by another method. The rubbing surfaces are first fitted accurately to the shaft, the journal and boxes are oiled thoroughly and the cap is pressed in place by the hand. The film of oil not allowing the surfaces to come in contact, they are held apart by the amount necessary to give a satisfactory running condition. The cap is now clamped in place by the two horizontal bolts shown at each bearing, which grip it to the main casting by a sidewise pressure and do not, in so doing, disturb its alignment or change the allowance made for the lubricant. This box has been in successful use on woodworking machinery for twelve years, at speeds up to 4,000 and 5,000 revolutions per minute.

Mr. G. W. Dickie told of the practice followed in the design of marine thrust bearings, calling attention in his introductory remarks to the fact that the use of the Parsons turbine for propelling steamships was doing away with the necessity

for the old stepped bearing. The thrust of the engine is arranged to nearly balance the thrust of the screw, and the only function of the end bearing is then to take care of any comparatively slight excess of one over the other. The general practice for steady work allows about 75 pounds per square inch pressure with 500 feet per minute for average velocity of rubbing surface. This makes the P. V. constant about 37,500 pounds. For war vessels and severe service generally, this limit is considerably exceeded.

Mr. H. G. Reist gave some information relating to the well-known Curtis turbine foot bearing. Here the end of the shaft is supported by a film of oil pumped under it at high pressure. A shallow recess is worked out from the center of the bearing equal to about half of its area. From this recess the oil is distributed across the thrust surfaces. It has been found that it takes a greater pressure to raise the shaft with its attached parts than it does to support it after it has been raised. The oil pressure for the various sizes of turbines varies from 180 to 800 pounds per square inch, with the initial pressure, as explained above, about 25 per cent greater. The oil film varies from .003 to .005 inch in thickness. A table below gives some idea of the practice on three different sizes of machines.

TABLE 2. CURTIS TURBINE FOOT BEARINGS.

Weight of Rotary Parts...	9,800 lbs.	53,000 lbs.	187,000 lbs.
Revolutions per minute...	1,800	750	500
Diam. of Bearing Seat....	9¾ ins.	16 ins.	22½ ins.
Pressure of Oil per sq. in..	180 lbs.	420 lbs.	650 lbs.
Quantity of Oil per min....	1 gal.	3½ gals.	6 gals.

Albert Kingsbury reported some interesting tests made in 1904 by the Westinghouse Electric & Mfg. Co. at their East Pittsburg works. A horizontal shaft was used, supported on two bearings, each 9 inches in diameter by 30 inches long, with a third bearing 15 inches in diameter by 40 inches long midway between the supporting bearings. This gives a total of 540 square inches for the projected area of the end bearings, and 600 square inches for the projected area of the central bearing. The shaft was driven by a Westinghouse 150 horse power direct-current railway motor; the electric power supplied to the motor being the only available basis for estimating the friction. The test runs were of about seven hours' duration each, starting with all parts cooled and bringing the shaft up to full speed as quickly as possible. If the speed was run at once to 1,000 revolutions per minute, it was found that the expansion of the shaft and the inner part of the bearings caused binding, hence it was necessary to accelerate slowly, allowing at least three hours for heating the outer parts. In the final run, No. 13, two of the bearings were somewhat damaged, apparently from raising the speed too rapidly.

As will be seen from the table of data and results of the tests, it was found possible to run the bearings with loads and speeds greatly exceeding the ordinary values in practice, even without water cooling the bearing sleeve. The extreme case of a successful test is shown in column 12, in which a run was made under 94,000 pounds load at 1,243 revolutions per minute, with only a very small amount of water run through the bearing sleeve merely for determining its temperature. The oil supplied, however, was cooled in all the tests except in No. 7 and the first half of No. 13. The values for *P V* in the various tests have been added for the sake of comparison with standard practice.

Several members contributed to the discussion of pressures, speeds, lubrication, cooling, and materials for sliding bearings. Mr. H. H. Suplee spoke of the necessity for distributing the metal in the bearing pedestal, not only with a view of giving it sufficient strength, but also designing it for the purpose of conducting the heat away from it as rapidly as possible. From this standpoint he criticised the practice of coring the box to allow the use of circulating water for cooling. The reduction in heat-carrying material brought about by the coring, the speaker claimed, was often the only thing that made water cooling necessary.

Mr. H. G. Reist described the practice of the General Electric Co. in proportioning journal bearings. The allowable pressure ranges from 30 to 80 pounds per square inch with a rubbing speed of from 400 to 1,200 feet per minute, the speeds and pressures being so proportioned that the maximum value for the P. V. constant does not exceed 50,000. The usual ratio of length to diameter is 3 to 1. For small and medium-sized bearings oil ring lubrication is used; above 12 inches in diameter the force feed plan is adopted. Rings must not be more than 8 inches apart. Thrust bearings are usually run submerged. Where it is impossible to get a proper area with a single thrust bearing the practice is sometimes followed of using a second surface with a spring suspension proportioned to carry about half the load.

Mr. John W. Upp gave additional information relating to the arrangement of the oil grooves in the bearings designed by the General Electric Co., and added the following table of allowances for oil in shafts of various sizes.

TABLE 4. ALLOWANCE FOR OIL.

Diam. of Journal.	Allowance.	Diam of Journal.	Allowance.
Inches.	Inches.	Inches.	Inches.
⅜ to 1	.002	9	.013
1⅛ to 2½	.003	10	.014
2¾ to 3½	.004	11	.015
4 to 4½	.005	12	.016
5	.006	13	.017
5½	.007	14	.018
6	.009	15	.019
7	.011	16 to 24	.020
8	.012	....	....

Roller Bearings.

Mr. Henry Hess, in speaking of the principles which control the design of ball and roller bearings, called attention to the antiquity of this method of reducing friction, and referred to the use which the ancient Egyptians and Assyrians made of rollers in transporting heavy masses of stone and building material. Continuing, he spoke of the influence of the bicycle in introducing the ball bearing to general use, and the disappointment which had attended attempts to employ it under more severe conditions. These disappointments led to a series of experiments by Prof. Stribeck, of the Neu-Babelsburg laboratory near Berlin, who came to the conclusion that sliding, roller, and ball bearings could be compared with each other

TABLE 3. TESTS OF 15″ x 40″ AND 9″ x 30″ BEARINGS.

"A" and "C" – 9″ x 30″ "B" – 15″ x 40″	Tests with Heavy Machine Oil.								Tests with Parafin Oil		
Test Number	3	4	5	6	7	8	9	10	11	12	13
Pressure on B lbs. per sq. in. nom. Area.	83	83	83	83	83	83	112	141	157	157	168
Pressure on A and C lbs. per sq........	82	82	82	82	82	82	114	146	161	164	175
Shaft Speed: R. P. M.	306	309	506	180	179	301	451	480	946	1243	1286
Shaft Speed: Ft. per min. B	1200	1215	1990	708	704	1180	1785	1890	3720	4900	5050
Shaft Speed: Ft. per min. A and C	720	730	1190	424	422	710	1070	1030	2220	2930	3030
Friction H. P. Total for A B and C....	12	12.6	21.7	6.43	5.12	10.1	16.	17.9	41.9	47.8	52.3
Friction Torque lbs. ft. Total A, B & C.	206	214	225	188	150	176	185	196	233	202	213
Average coeff. of Friction for A B and C: Starting (cold)	.121	.146	......	......	......	......	......	......	......	......	......
Average coeff. of Friction for A B and C: Running..	.0041	.0045	.0048	.0040	.0032	.0037	.0029	.0024	.0025	.0022	.0022
Value of P V for B..................	99,600	100,895	165,170	58,764	58,432	97,940	199,920	266,498	584,040	769,300	848,400
Value of P V for A and C.	59,040	59,860	97,580	34,768	34,604	58,220	119,840	150,380	364,080	480,520	530,250

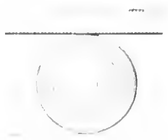


Fig. 1.

Fig. 2.

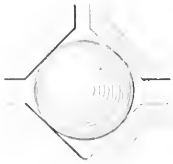


Fig. 3.

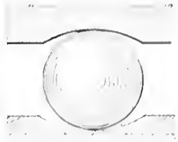


Fig. 4.

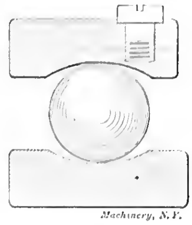


Fig. 5.

Relative Values of Ball Bearing Surfaces.

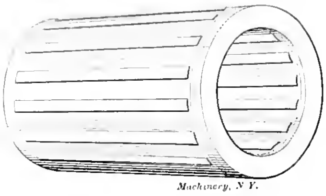


Fig. 6. Mossberg Roller Bearing.

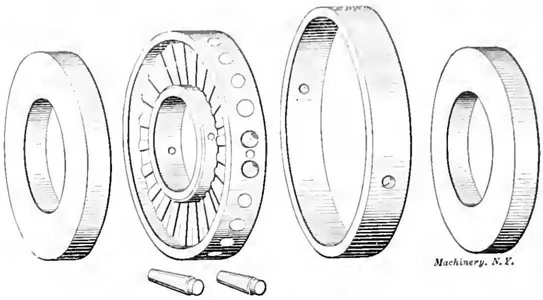


Fig. 7. Mossberg Roller Thrust Bearing.

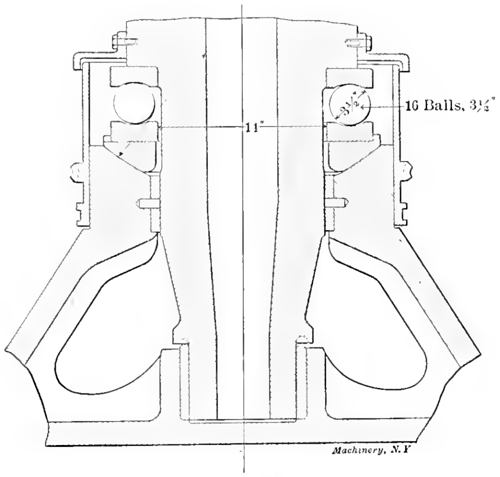


Fig. 8. Ball Bearing Gun Mount.

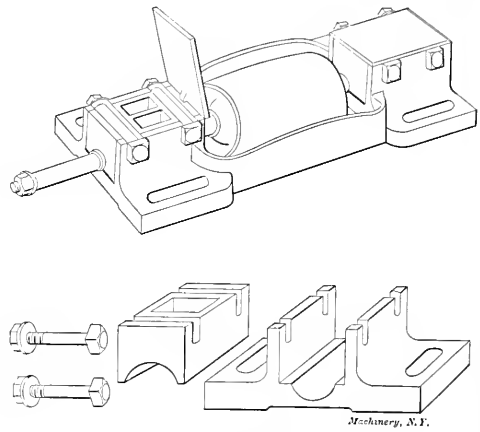


Fig. 9. A Non-binding High-speed Bearing.

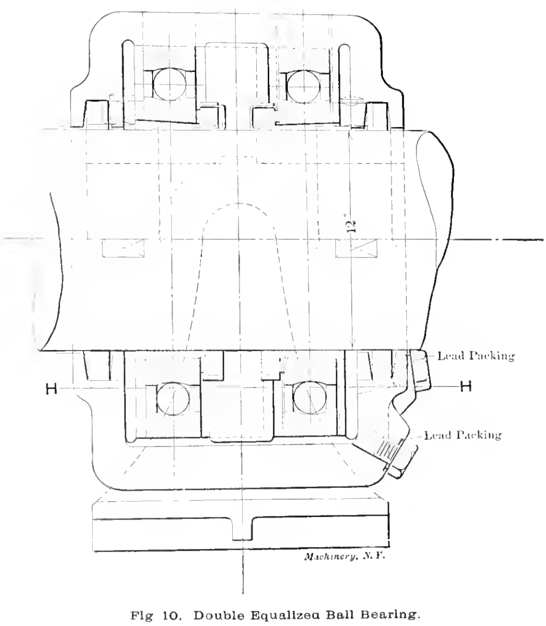


Fig 10. Double Equalized Ball Bearing.

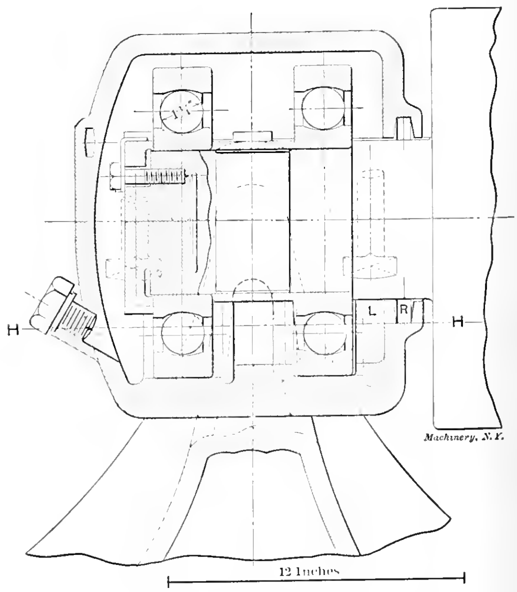


Fig 11. Equalized Ball Bearing applied to Calender Roll.

by reckoning the specific load of each in accordance with the following expressions:

TABLE 5. EQUIVALENT PROJECTED AREA OF BEARINGS.

Sliding Bearings......	Length of journal × diam. of journal.
Roller Bearings.......	$\frac{1}{5}$ No. of rolls × roll length × roll diam.
Ball Bearings........	$\frac{1}{5}$ No. of balls × square of ball diam.

His tests showed that the co-efficient of friction for starting in the case of the roller bearing was not much greater than the co-efficient of friction when the parts were in motion. In the case of the ball bearing there is still less difference between the two co-efficients. This fact is important in the use of these bearings in the traction field, since here the power required for acceleration is usually greatly in excess of that required to keep the car or carriage in motion. The velocity of the ball or roller does not make great changes in the value of the co-efficient, within a wide range, wider for rolls than for balls. The experiments led to the conclusion that the proper specific load for roller bearings was from 6 to 11 kilograms per square centimeter, or from 85 to 155 pounds per square inch. The lower value should be used for soft rolls and shafts and the higher value when the rolling surfaces are all hardened and accurately ground. The design of roller bearings should be such that the rolls are free, of not too great length, and ground accurately, straight and true to size. Under these circumstances the rolls straighten themselves automatically as they leave the zone of pressure, doing this better than when confined in a cage.

Mr. Frank Mossberg gave particulars relating to the design and manufacture of the roller bearing which is known by his name. The principles he laid down are the result of a number of years' experience in the making of this form of bearing and differ in some interesting particulars from the ideas expressed by Mr. Hess. Mr. Mossberg's experience leads him to believe that since the contact between the roller and a journal or box is theoretically a line contact, it is not reasonable to increase the size of the rolls for the sake of increasing the capacity of the bearing. On the contrary, the rollers are made as small and numerous as the desired rigidity of construction will allow, the projected area of the journal covering at least seven rolls and preferably more. The length of the journal is made about 1½ times the diameter. The following table gives some particulars as to this line of roller bearings and Figs. 6 and 7 give some idea of the construction of two of the various styles.

TABLE 6. MOSSBERG ROLLER BEARINGS.

Diameter of Journal.	Diameter of Rolls.	No. of Rolls.	Safe Load.
Inches.	Inches.		Pounds.
2	$\frac{1}{4}$	20	3,500
$2\frac{1}{2}$	$\frac{5}{16}$	22	7,000
3	$\frac{3}{8}$	22	13,000
4	$\frac{7}{16}$	24	24,000
5	$\frac{9}{16}$	24	37,000
6	$\frac{11}{16}$	24	50,000
7	$\frac{13}{16}$	22	70,000
8	$\frac{7}{8}$	22	90,000
9	1	24	115,000
12	$1\frac{1}{4}$	26	175,000
15	$1\frac{3}{8}$	28	255,000
18	$1\frac{3}{8}$	32	328,000
20	$1\frac{1}{2}$	34	400,000
24	$1\frac{1}{2}$	38	576,000

Again, as opposed to the principles expressed by Mr. Hess, the Mossberg bearing is confined in a cage, made as stiff and rigid as is practicable. The journal and shaft are of medium carbon steel, spring tempered. The outer shell is made very hard, of high carbon steel. The starting co-efficient for a bearing of this type is about .002; no figures have been obtained for a running co-efficient. This bearing has been very largely used for rolling mills, especially for cold rolling of precious metals.

Ball Bearings.

Mr. Hess in the discussion on ball bearings continued the account of the experiments undertaken by Prof. Stribeck. While in a given space the roller bearing should be much more efficient than the ball bearing, there are practical difficulties in the way of utilizing the full efficiency of the roller. To get a uniform bearing the full length of the roll, its axis must in the first place lie exactly parallel with the axis of the journal as must also the axis of the box in which the bearing is contained. Again, the journal must not be so long that an appreciable amount of distortion takes place within its length. This will effect the uniform bearing of the roll on the surface of the box and journal. These considerations lead a second investigator, a Mr. Riebe, to believe that a ball bearing of such a design as to utilize to the last degree the capabilities of the materials of which its component parts were made, and using materials carefully selected for the functions they had to perform, would practically give better results than the theoretically more efficient roller bearing. Experiments were accordingly undertaken in the first place to determine the most efficient form of rolling surface for use with a ball bearing. Figs. 1, 2, 3, 4, and 5 show the different shapes experimented with. The arrangement shown in Fig. 1 develops the least amount of friction. Figs. 2 and 3 with three and four point bearings respectively develop a greater amount of friction without any corresponding increase in capacity. By confining the ball, as shown in Fig. 4 within a two point bearing composed of curves conforming rather closely to the outline of the ball, nearly as great efficiency was obtained as with the arrangement shown in Fig. 1, with a much greater carrying capacity. The contact between a perfect ball and a perfect planed surface or surface of greater curvature than its own, is theoretically in the form of a point. This predicates an infinite unit pressure at this point. This condition is of course practically impossible, the actual result being that the high pressure at this point jams together the metal of the ball and the race until a sufficient area of contact has been established to balance the strain due to the load, and the counter stresses which the physical characteristics of the parts affected are able to oppose to it. Since in Fig. 4 the ball is confined between surfaces approximating its own contour, this distortion for a given load is very much less than it would be were it rolling on a plane surface. Its capacity is consequently very much greater and, as before stated, its frictional resistance is nearly as small. Having determined the form of the bearing, experiments were next undertaken to determine the most suitable materials and the most suitable methods of treating these materials to give a high enough capacity to the bearing to make it unnecessary to use more than one set of balls. The accomplishment of this purpose makes it unnecessary in most cases to use more than a single set in a bearing. Fig. 5 shows the way the balls are inserted between the inner and outer races of a bearing of the type described. A filling piece is inserted in a groove of the race at a point where the ball is not under pressure, this filling piece being shaped to form a continuation of the race.

Mr. Hess showed a number of examples of the application of this type of bearing from which three only have been selected for illustration. Fig. 11 shows a double bearing as applied to the journal of a calendar roll. Since the pressure here is always in one direction, it is possible to use two bearings by mounting the box on a swivel to equalize the pressure between them. The bearings are thus unaffected by such distortion in the shaft as taken place between them. The load of this journal is 56,000 pounds. Some of the dimensions are given in the cut. Fig. 8 represents a gun mount which uses balls 3½ inches in diameter.

Mr. Eveland called attention to the impossibility of making balls of uniform size. In practice they are made as closely to standard dimensions as possible and then graded. Some manufacturers pack all which are about standard in one box, those .00025 inch larger in another and those .00025 inch smaller in a third, etc. Users are often ignorant of this practice and dump the contents of these three packages together indiscriminately. In grading the product in relation to its accuracy, manufacturers generally consider all balls which come with .00025 inch of the standard size as "quality A," all those which come within .001 to .002 inch of standard size "quality B," while for "high duty," balls of .0001 inch variation are selected. It is wiser to purchase balls of the manufacturer than of the dealer since the latter may not be able to resist the temptation to mix balls of different qualities together and sell them for the price of the highest.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

FEBRUARY, 1906.

PAID CIRCULATION FOR JANUARY, 1906,—24,627 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a specialedition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

AWARD OF PRIZES.

In the December number six prizes were offered, one of $20, one of $10 and four of $5 each, for the best and most practical suggestions for the improvement of the reading pages of MACHINERY.

The suggestion which in our judgment is entitled to the first prize has been made by two contestants and this prize is accordingly divided between them, making the awards as follows:

Divided first prize, John S. Myers, Philadelphia, Pa., and M. Joachimson, New York City, $10 each.

Second prize, E. W. Beardsley, Waterbury, Conn., $10.

Third prizes, W. H. Sargent, St. Johnsbury, Vt.; J. C. Steen, West Lynn, Mass.; Chas. H. Cross, Eau Claire, Wis.; and Wm. C. Terry, Pittsburg, Pa., $5 each.

* * *

MACHINE SHOP DONT'S.

In this issue we give another list of machine shop don'ts compiled by Mr. H. E. Wood, believing that they express in small compass much that has to be learned by every good machinist, although of a negative nature. For when we pause to reflect the command "thou shalt not" seems to be a large part of human education in first principles generally. The child is cautioned not to go near the stove; not to play with knives; not to go in dangerous places; not to throw stones at windows, and not to do many other things, the doing of which is a menace to the comfort and well-being of himself and others. The decalogue itself is largely negative and the laws of all countries (except, perhaps, Russia), tell what a man must not do. In the case of the machine shop don'ts, many of them could have been expressed equally as well in the positive sense, but perhaps not so forcibly because of the peculiar quality of the average human mind that it seizes onto a fact and makes more of it when learned by inference than by direct telling. The philosophy of don'ts might be likened to danger signals on a highway where accidents are very likely to happen. It would be impracticable and foolish to put up signs on the straight course telling drivers to go in the middle of the road, etc., but it is pertinent at the danger points to put up notices that certain precautions should be observed if disaster is to be avoided. In short, we assume that human instincts are in general correct and that the minds of men proceed along sane and conservative ways but all are liable to make some mistakes and some of these may be pointed out to the young beginner—and the journeyman too, perhaps.

BOILER PLANT ECONOMY.

In a paper contributed to the 1905 proceedings of the American Water Works Association by Charles A. Hague, which is abstracted in the *Engineering Review* of this number, attention is called to the discrepancy that usually exists between expert tests upon steam apparatus and the results of everyday operations. This difference is attributed to the difference in skill and painstaking care on the part of those who make the expert test and those who operate the station from day to day. While this condition exists to a considerable extent in respect to steam engines, it is in the boiler room where the greatest amount of money is lost in modern power plants. The steam engine has been subjected to all sorts of refinements, even to the extent of polishing the cylinder heads and the faces of the pistons to reduce initial condensation, and with reasonably good care they should operate regularly with fair economy. The boiler room, however, does not get so great a share of attention. The boiler setting cracks, the firemen are careless or ignorant, and the room is so dirty and hot that the engineer prefers not to spend a great deal of his time there. What may be done, however, by properly educating and placing the fireman under expert supervision and also by maintaining the boiler settings in good condition, is illustrated by the results accomplished by one of the largest public service corporations in this country. They have taken rigorous measures to maintain boiler room efficiency and have employed a chemist to analyze the chimney gases. The settings were made absolutely tight and the dampers and grates regulated in accordance with the analysis of the chimney gases. The results indicate that the first year 10 per cent or over $100,000 worth of coal will be saved. It is only by considering plants of this magnitude that the meaning of the loss existing to a less extent in smaller plants can be fully understood. The figures indicate, however, that in many smaller power houses it would pay to give more attention to the boiler room.

* * *

ON PROMOTING INVENTIONS.

One of the difficult things for the editors of a technical paper to decide is the advisability of publishing descriptions of patented inventions which have not been perfected and placed on the market. Such descriptions benefit no one directly but the inventor, for no one can make and use the machine, because of the patents; and no one can purchase it, because it is not ready for the market. If the device is of unusual interest, however, from a mechanical standpoint, it may furnish interesting material for the reader, and it may be advisable to publish a description. But in any case it would seem to be outside the bounds of propriety to give space to an account of a machine that is in the infant stages of its development.

As a case in point, descriptions of a machine have recently been sent to the technical press for publication, which might easily give the impression that it has been so far perfected as to be already a practical success. The invention is a composing machine designed to compete with the Lanston Monotype, which latter consists of two machines that must operate in conjunction. One has a key-board like a typewriter and when the keys are depressed corresponding holes are punched in a roll of paper. The other casts and spaces the type under the guidance of the punched roll on the plan that a piano is operated by the perforated roll of an automatic piano player.

In accordance with our usual custom, we investigated the new machine and found that it was designed on a much simpler principle than the Lanston, but that, unfortunately, the working model was in no sense an operative machine, since several important parts of its mechanism have not yet been made to properly perform their functions. In short, the machine is largely on paper, although a considerable amount of experimenting has been carried on. The attempt to bring a machine in so incomplete a state prominently before the public, presumably with the expectation of raising capital to conduct further experiments, is not in our opinion the best policy, even for a promoter; and if a technical journal is to use such matter it should at least state the facts as they are so that no investor may be misled by published statements in a journal which he very likely looks upon as more or less of an authority.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The inconvenience of referring to a map in the open air is so great as to preclude its use except in case of positive necessity. The *English Mechanic* refers to an invention called the microphotoscope, invented by a Berlin chemist, which though no larger than a cigar-case, permits of consulting the map of a whole district by night as well as by day, and in any kind of weather. The map is photographed in miniature on a plate of ground glass, which is illuminated by a small incandescent lamp supplied, when required, with current from a battery, while a lens can be adjusted to the observer's sight.

Gold should not be used in repairing platinum dishes since its melting point is materially lower than that of platinum, says the *Mining Reporter*. When the latter metal itself is used, the repaired dish is as good as new. To effect a good weld, brighten the surface to be repaired and cut a small piece of foil to fit the spot that has been damaged. Heat both to incandescence and place the patch in the proper position. Then, while white hot, the patch is tapped gently with a suitable small hammer until the weld is accomplished. Skillful workmanship will give a practically new dish or crucible.

One of the most difficult problems in civil engineering is to accurately gage the flow of rivers. It is hard to find just what the average rate of flow is, for the water travels faster at the surface than at the bottom or near the banks. An interesting method of gaging streams by chemical means was described in a paper presented before the Institute of Civil Engineers by Charles E. Stromeyer. It consists briefly of adding a certain quantity of brine to the stream and of taking at a point farther down samples which were subjected to very accurate analysis. The increase of salinity gave a factor by which it is possible to calculate the stream discharge with a possible error of less than 1 per cent.

An obituary of James C. Warner, who died in Chicago, November 14, 1906, was published in a recent issue of the *Western Electrician*, and it reveals a mechanical career of unusual interest. Mr. Warner was an expert mechanic of a type now rarely found, being an instrument maker, engraver and electrician. His father and grandfather before him were highly skilled mechanics and his son, Ernest P. Warner, has in his possession a lathe nearly 120 years old which was used by his grandfather. One of the most interesting facts connected with his life to the world at large is that he was employed in New York to make the first telegraph instruments used by Morse on the historical telegraph line between Washington and Baltimore.

A textile paper, in a short article on noisy gearing, says one of the details of construction that may cause noise is that the depth of the tooth spaces is not right. In this respect gears are more often cut too deep than not deep enough, and it is worse to have the driver too deep than the driven gear. Another cause of noise may be that the cutting is not central. This may be shown by gears being noisy in one direction and quiet when running in the other direction. Again, the center distance may not be right; if meshing too deep, the outer corners of the teeth of one gear may strike hard against the roots of the teeth of the other gear. Still another reason for noise may be found in the fact that the frame carrying the gear shafts may be of such form and size as to give off sound vibrations.

In an editorial on the centrifugal pump the *Practical Engineer* says in considering the advantages and disadvantages of turbine pumps that it is well to assume a general rule that where the head expressed in feet is greatly in excess of the quantity in gallons to be delivered, a reciprocating pump will give the better results. An example is given of a turbine pump built by well-known makers designed to deliver 500 gallons per minute against a head of 500 feet in which the efficiency is about 72 per cent. But the best efficiency possible with a turbine pump designated to deliver 50 gallons against the same head would only be about 60 per cent. In the latter case not only would the efficiency be reduced but the price of a turbine pump would doubtless be more than the best type of three-throw reciprocating pump.

The power of running water to move large blocks of stone is well illustrated at the Assouan Dam across the Nile, says the *London Globe*. A large mass of rock has been dislodged from the bed of the river by the powerful current issuing from the barrier, and thrown backward against the masonry. This boulder is 17 feet long by 12 feet broad, and 7 feet in thickness. It is estimated to weigh sixty tons. Geologists, who are perhaps too often apt to assume that any such large block separated from its parent mass must have been moved by ice, should take special notice of this. It was estimated by Mr. W. Hopkins, of Cambridge, England, that while a current of ten miles an hour might move a spherical mass of stone five tons in weight, a current of twenty miles an hour would move a block 64 times as heavy—that is to say, a weight of 320 tons.

A correspondent of *Power* gives an amusing example of prejudice in steam engineering practice and of truly wonderful gain in economy when that prejudice was satisfied. He had charge of the erection of a small steam-driven electrical plant and when it came to the exhaust pipe of the engine he arranged it so that it discharged horizontally over a small stream. This did not suit the ideas of the resident "engineers" and they unanimously agreed that the erector might be all right on electrical machinery but that he did not know much about steam engine practice. The owner of the plant was impressed by their talk and asked the erector if the engine would not work better if the exhaust pipe went up through the roof, to which emphatic reply was made that it would not. But when the plant was visited three or four weeks afterward the erector found to his surprise that the exhaust pipe had been changed to shoot the steam upward through the roof and learned with still greater surprise that the plant was operated with one-third less coal than before!

The great difficulties involved in establishing standard units of weights and measures are not always appreciated. In discussing the subject at a meeting of the American Water Works Association, Dr. W. P. Mason, of Rensselaer Polytechnic Institute, related the following incident: I very well remember some years ago of a boy stepping into my laboratory with a telegram coming from one of the officials of the Standard Oil Company. It read, "Wire us at once weight of a gallon of water in grains, four decimal places, at 60 degrees Fahrenheit." I said to the boy, "Just wait a minute, I will write a telegram." I thought it was the simplest thing imaginable to do. I couldn't understand why they had sent so simple a problem to me. All I had to do I thought was to go to my library and write the telegram at once. I didn't keep that boy waiting, because it took me just three months to write that telegram—and when I wrote it, it was not right. I found if I only had books enough I could get any kind of a result. The few authorities who agreed had taken the results from each other. I found as a matter of interest to me that there was but one pound fixed by statute in the United States, and that was the Troy pound, which had been brought from England for use in the Mint. It may be worth while stating that we now, in this country, possess the standard Troy pound. Years ago we sent a commission over to copy the English standard. They brought such copy here, and it is now in the mint at Philadelphia. Since then the British pound has been burned, so we possess the standard. That is the only weight except those of the metric system that is upon the statute books to-day, all other weights being recognized merely in common law.

PLANER CLAMP.

In the November, 1905, issue a contributer described a planer clamp of the type having a pentagonal piece pivoted at one end to act as blocking of adjustable height. The same fixture, except that the block is a hexagon, was illustrated in a recent issue of *Portefeuille Economique Des Machines*, and with it was shown two applications of a similar device, but of somewhat different construction. This device is shown in Figs. 1 and 2, the block being in this case rectangular and with

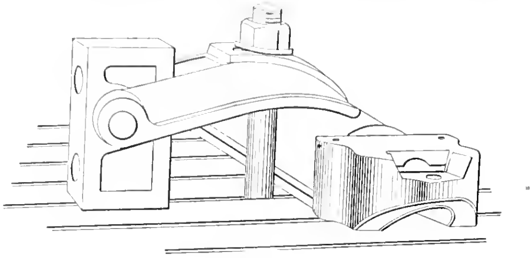


Fig. 1. The Device used as a Clamp.

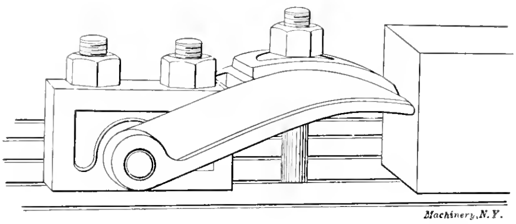


Fig. 2. Used as a Strut.

two holes drilled through to clamp it rigidly to the platen, as shown in Fig. 2. The clamp, it will be observed, is made with the pivot in such a position that the blocking has four different heights, according to the side on which it is laid. In two of these postions it can be bolted to the platen so that the clamp may be used as a strut against the side of the work as is desirable when planing a piece all over.

ALLOWANCES FOR PRESSED FITS.

In making allowances for pressed fits, says Mr. S. M. Howell in *Popular Mechanics*, there should be a difference in size of from 0.002 to 0.003 inch for each inch of diameter. The required pressure in tons will be the allowance in thousandths multiplied by the diameter in inches and by 1½. It will be apparent that with pieces of very large size the necessary pressure would be very great indeed. An allowance of about 0.010 inch on these cases will be sufficient and would bring the required pressure within more convenient limits. It is also true that the driving allowance must in many cases be limited by the strain which the job will safely stand. The material and thickness of the metal which surrounds the hole, the length of the forced shaft, etc., these points are in some cases governing considerations. As a general thing, however, in ordinary cases when it is not necessary to go to extremes, the given rule of 0.002 inch per inch of diameter may be used on all work up to about 4 inches diameter. For larger pieces a total allowance of 0.008 to 0.010 inch per inch of diameter is about right, regardless of size. About 0.007 will make a 40-ton fit on a 4-inch axle. When the required pressure is specified, divide the pressure in tons by 1½ times the diameter, in inches. The quotient will be the required allowance in thousandths inch. For driving fits, a total allowance of 0.003 without regard to size is good practice with pieces larger than 1½ inch. For smaller pieces apply the first rule given for pressure fits and shrink fits. In making a press fit with an old wheel, which has been previously pressed on and off, the bore has been surface-hardened by the pressure to which it has already submitted, and the force required to press the wheel on will be about double that required for new work, or, the forcing allowance may be reduced to one-half regular amount.

NEW OIL PUMPING PROCESS.

The Southern Pacific Co. is soon to make a test of a new pipe line pumping process for crude oil, which is expected to greatly reduce the cost and difficulty of pumping long distances, says the *Railroad Gazette*. A special 8-inch pipe line 31 miles long has been laid from Volcan Siding in the Kern river oil fields to Delano, Cal., and a pumping plant consisting of three 200 H. P. boilers and a Dow compound duplex steam pump with a capacity of 1,000 gallons of oil a minute, has been installed at Volcan.

The pipe line is laid with 8-inch standard pipe made by the National Tube Co., corrugated on the inside with six grooves, each 3-64 inch deep and ½ inch wide, each groove making two complete turns in a 20-foot length of pipe. The pipe is corrugated by a special process developed by Mr. J. D. Isaacs, assistant engineer maintenance of way, Southern Pacific Co. A plant for corrugating the pipe has been built near Bakersfield, Cal., on the side of a hill, and the pipe is rolled by gravity through the various processes from the time it is unloaded from the cars until it is loaded on cars again. The corrugating machine makes the pipes somewhat polygonal in shape and careful tests are made to discover any defects. Each length of pipe is tested with 1,200 pounds of water pressure, both before and after corrugating. This testing is done by the Pittsburg Testing Laboratory and Robert W. Hunt & Co., and only selected lengths are used. Each length is weighed and measured and a separate record is kept of it.

In operation water is pumped into the pipe with the oil in sufficient quantities to form a shell around the oil which does not come in contact with the surface of the pipe. The grooves cause the water and oil to advance through the pipe with a rotary motion, and it is claimed that with this process oil can be pumped as easily as water. At the outlet a centrifugal separator removes the water from the oil. The pipe line is laid with depressions or traps every 400 feet. These traps prevent the pipe from running entirely dry, in case the pumping stops, and assist in getting the stream of oil surrounded with water under way again. If the tests to be made prove the new system to be successful it will probably be adopted on a large scale on the Pacific coast.

[It will be understood from the foregoing description that this ingenious scheme, which endeavors to make a complete concentric film of water around the body of oil, does it by means of "rifling" grooves which cause the whole mass to rotate, which action is expected to prevent the water from collecting at the bottom as it otherwise would do. The outcome of the scheme will be awaited with much interest.—EDITOR.]

THE COMMERCIAL PUMPING ENGINE.

Paper presented by Chas. A. Hague before the Twenty-fifth Annual Convention of the American Water Works Association.

In this paper Mr. Hague, the well-known consulting engineer of New York, enters fully into the subjects of specifications for the design and construction of pumping engines and also discusses the economic performance of such engines. In what follows are extracts from the address, which include some of the important points brought out.

Some of the first things needed to be known by the builders of pumping engines are the conditions of service under which the engine is to operate. These can be conveniently made known by stating the number of gallons required to be pumped per 24 hours, giving the total water load upon plungers, including fricton of suction and delivery mains, static head, point and manner of delivery of the water, and making this statement in a positive manner, releasing the engine builder completely from all responsibility for the details making up the total load, but requiring of him an engine capable of delivering the given quantity of water against the aggregate working pressure under the stated conditions.

The methods of determining the capacity of the main pumps vary according to the ideas of the builders and buyers; sometimes a weir only; sometimes a weir in conjunction with the plunger displacement. The writer has reached the conclusion that with proper pump construction, the plunger displacement is adequate and conclusive, care being taken that the pump valves are reasonably and practically tight under pressure and of a design, including their seats, which will place their capa-

bility of holding water beyond doubt. When it is realized how much work and carefulness is necessary in constructing and arranging a suitable weir, the clean cut, unmistakable performance of multiplying the actual areas of the plungers easily measured, by the length of the stroke also easily and accurately determined, will be found to be much preferable; especially so when it is considered that an excess allowance of say five per cent in plunger area can be provided to make up for possible deficiency at the stated speed of travel, so as to insure the actual quantity called for.

The area of pump valve openings is a subject which has led to many arguments and disputes during the development of pumping machinery, the reference often being to percentage of plunger area in denoting the aggregate "valve area" of the pump. But the valve area by itself, that is, the number of square inches of opening through the valve seats, will not answer the question in relation to the plunger area. The valve area is a factor of the quantity and really independent of the incidental area of the plunger, and as a matter of fact the flow of water through the valve seats must not go above a certain velocity if the proper relation of the pump is to be retained. It matters not whether we consider a small plunger at a high rate of travel or a large plunger at a slow rate of movement, which means that as long as the quantity of water flowing per minute and the valve area remain constant the changing of the plunger will matter but little. If we talk about the valve area in terms of the percentage of the plunger area, the speed of the plunger must be considered, and this has led the writer to adopt a rule to govern in such cases, which is to divide the feet traveled by the plunger per minute by two and let the result represent the percentage of the plunger area for the valve seat openings. For example:

Plunger Speed per minute in feet.	Percentage of Plunger Area in the Valve Seats.
100 feet.	50 per cent.
150	75
200	100
250	125
300	150

The moving parts of a pumping engine should have strength and stiffness to avoid tremor and vibration while at work; the steam pistons should be light and strong with liberal bearing surfaces, and self adjusting packing; the latter day requirements calling for polished faces both for the pistons and the inner surfaces of the steam cylinder heads to reduce the radiation to the lowest possible limits. The piston rods are made and attached in various ways and of slightly different material, but the most favored probably are of forged open hearth steel with about four-tenths per cent carbon, highly finished all over and not draw filed. They are attached to the pistons sometimes by forcing and sometimes not; generally in large engines secured by a nut or key. Builders of good repute follow slightly different methods but they all seem to arrive at satisfactory results. The piston rod is a beautifully simple detail, but it can be made badly at times even at considerable expense. The piston rod packing is generally in these days of high and dry steam, of the semi-self-adjustable metallic construction; the perfectly cylindrical parallel form of the rod coupled with high polish and finish, when such is obtained, going a long way toward the long wear and good service of the metallic packing; in fact it pays a large profit to the buyer to have some money spent upon the character of the piston rod.

Specifications for Materials.

In the better practice forged steel cross heads are used where practicable or appropriate; having the piston rods a close fit in the sockets and secured by means of forged steel nuts of extra depth in proportion to diameter. Cast steel cross heads are also successfully used where a competent metal properly annealed may be obtained.

In crank and fly-wheel pumping engines the economical production of the very highest quality of solid open-hearth steel forgings, and center forged steel details for steam machinery is gradually bringing the grade of various parts of pumping engines up to the highest known levels for such work. Although costing a small percentage more than wrought iron, the very best and really cheapest material for piston rods, connecting rods, crank shafts, cranks, distance rods, and other details of like nature is steel, forged under hydraulic pressure from clean, sound ingots somewhat larger in mass than the finished product, and the piece properly annealed. Such forgings not infrequently have a tensile strength of over 80,000 pounds, and an elastic limit of 50,000 pounds, with an elongation of 25 per cent before parting under test.

Among the points to be mentioned in the specifications are the following: The iron castings should be free from blow holes, flaws, cold shuts, blisters, and defects of any and all descriptions. Soft spots left by core chaplets to be completely remedied and obviated if occurring; and the buyer of the machinery should have the right to reject any and all castings not thoroughly sound and which may be discovered to be fractured or otherwise damaged or defective after the engine is erected. The castings should be smooth and true to form, sound, of tough, strong material and of proportionate dimensions.

The cast iron used in the steam cylinders, steam distribution valves, and the pump plungers should be close and fine grained, hard as can be practicably worked, uniform, and with good wearing qualities.

The framing, flywheels where used, pump bodies, and other fixed parts should be of a first class machinery mixture, possessing a tensile strength of at least 20,000 pounds per square inch.

If there are any steel castings used in the construction, they should be thoroughly annealed, and have a tensile strength of not less than 60,000 pounds per square inch and not more than 65,000 pounds per square inch; and have an elongation of 15 per cent before parting.

All steel forgings used in the construction should have a tensile strength of not less than 75,000 pounds per square inch, an elastic limit of not less than 35,000 pounds per square inch, an elongation of not less than 25 per cent, and a reduction of area of not less than 35 per cent, all of the above mentioned requirements based upon standard samples and methods.

All wrought iron used in the construction should be tough and uniform in character; and specimens broken in a testing machine should show a tensile strength of at least 55,000 pounds per square inch, and an elongation of 15 per cent in eight diameters.

All rods should be formed, whether rolled or forged, in one homogeneous continuous piece without weld. Any evidence of a weld in such pieces should subject same to rejection from the work.

The composition metal used should consist of the best quality of new material only, of a mixture or mixtures specially adapted to the particular work in each case.

The babbitt metal used should be of a quality which will show upon analysis to be that required with reference to the percentage of pure tin, percentage of antimony, and percentage of copper; and the buyers should have the right to have such analysis made whenever desired, but at the buyer's expense.

All rivets used, if any, should be made of the best refined iron, and should be capable of being bent cold until the sides are in close contact without any signs of fracture at the convex side.

Duty and Economy of Pumping Engines.

During the past twenty-five years there has probably been nothing concerning the capabilities of pumping machinery so much and variously discussed as its economic duty; or, the ability or inability to develop more or less foot pounds of work upon one basis or another of comparison, mostly per thousand pounds of steam consumed, or per million heat units utilized. Twenty-five years ago 60,000,000 foot pounds duty was a general guarantee for water works engines, with occasionally an engine of special design aiming to show 100,000,000 foot pounds, the advocates of the higher type and more costly machine arguing that the saving in fuel represented by the greater economy would more than pay the interest upon the difference in cost of the machinery. This saving was a fact, upon the showing of the returns provided the engines were equal in other respects, principally as to the ability of the machine to successfully and continually pump water without unusual interruption on account of stoppage and break down and needed repair. Years ago, the writer took the ground that the

first duty of a pumping engine is to pump water and sees no reason to change that idea to-day; but in the early days of higher duty than about 60,000,000 foot pounds, the engines were not built as a rule quite so sturdy for the hard work of pumping as their lower duty competitors, and if durability, smoothness of operation, and decreased cost, had not gradually forged to the front, in the construction of pumping machinery for water works, the present admirable results would not have been attained and reached so high a level as at present.

In large engines, and under good boiler conditions, yearly duties are maintained as high as from 120,000,000 to 135,000,000 foot pounds per 100 pounds of coal burned; and, of course, it must be borne in mind that no matter how high a steam efficiency a pumping engine may show, the results at the boilers in producing the steam have a controlling influence upon the yearly reports upon economical operation.

For example, with a pumping engine giving an indicated horse power with the consumption of 12 pounds of steam per hour, the actual duty in coal consumed would be as follows:

With 8 lbs. evaporation in the boilers, 120,000,000 duty.
With 8½ lbs. evaporation in the boilers, 130,000,000 duty.
With 9 lbs. evaporation in the boilers, 135,000,000 duty.

The complaint has often been made that pumping engines do not give so high a duty in regular service as upon the test with experts. In general terms this must be admitted and because the experts know how to adjust the engine and operate it to comply with the conditions found to exist, better than the attendant usually found in pumping stations; and this difference in operation in favor of expert work is because the expert by his more extended knowledge of the subject is a more valuable and a higher paid man than the regular attendant as a rule. But it would not pay for all the difference in economy to employ scientific experts to operate a pumping station, although for purposes of contract comparisons the very best work of the engine is sought to be brought out by the contractor, and this is just what the expert does, leaving it to the regular attendant to approximate as nearly as possible under every day conditions and multitudinous cares, the pace set at the regular test.

The adaptation of a pumping engine to its conditions so far as may be, is the key to highest efficiency under the conditions imposed. There are advocates of high speed, of high steam pressure, of high rate of revolution, and other singled out and isolated factors, but the general combination wherein the machine best meets the conditions is what will yield the best results, and not the exploiting of any particular seemingly important factor by itself. And, as an example of this fact it may be noted that the pumping engine which holds the high duty record in this country, if not in the world, has the following conditions to work under:

Capacity per 24 hours, 15,000,000 U. S. gallons.
Piston speed, 197 feet per minute.
Rotative speed, 20 revolutions per minute.
Water load against pumps, 126 lbs. pressure.
Steam pressure per gage, 126 lbs. pressure.
Indicated power, 802 horse power.
Mechanical efficiency, 96 per cent.
Steam per hour I. H. P., 10.68 pounds.
Duty per 1,000 lbs. steam, 179,454,250 foot pounds.

Regarding high piston speed, the best record known to the writer as to pumping engines is 607 feet per minute, where the duty per 1,000 pounds of steam was 157,843,000 foot pounds, showing that higher piston speed alone will not answer.

Regarding high steam pressure the record seems to be 200 pounds and a duty of 149,500,000 foot pounds, showing that high steam pressure in the absence of other ruling conditions or proper fitness falls short of the best performance.

Regarding thermal efficiency, or the actual economy of heat employed with reference to absolute temperatures, even the greatest thermal efficiency does not in the presence of adverse conditions in some other direction, equal the engine working under the best general fitness of things as will be seen by the following:

Thermal Efficiency.	Duty per 1000 lbs. Steam.
22.8 per cent.	149,500,000 foot pounds.
21.63 per cent.	178,497,000 foot pounds.
21. per cent.	179,454,250 foot pounds.
20.85 per cent.	173,620,000 foot pounds.
20.78 per cent.	176,419,600 foot pounds.

What is considered the record for general all round efficiency for a pumping engine up-to-date is as follows:

Capacity per 24 hours, 30,000,000 U. S. gallons.
Steam pressure gage, 185 lbs. per square inch.
Piston speed, 195 feet per minute.
Duty per 1,000 lbs. steam, 178,497,000 foot pounds.
Duty per million heat units, 163,925,300 foot pounds.
Steam per hour, I. H. P., 10,335 pounds.
Thermal efficiency, 21.63 per cent.

With reference to the steam economy of the higher type of pumping engines and its repetition in different engines it may be noted that covering a period of more than three years, five pumping engines of a similar type, of different builders, and situated many miles apart, gave steam per indicated horse power ranging through the following figures:

10.33 pounds per indicated horse power per hour.
10.63 pounds per indicated horse power per hour.
10.78 pounds per indicated horse power per hour.
11.01 pounds per indicated horse power per hour.
11.10 pounds per indicated horse power per hour.

It hardly seems probable that materially higher efficiencies will be obtained in the near future at least, and not very much higher efficiency is possible with the steam pressures seemingly practicable to employ in pumping stations; super-heat in the steam will no doubt carry the record to slightly higher figures, perhaps to 200,000,000 of foot pounds or a trifle higher, as the reheating and superheating of the receiver steam by means of coils in the boiler connections or smoke flues will also tend in the same direction, but, of course, net gain is what is sought, and fancy duty figures at the expense of heat in some other part of the plant will not add to real economy in the long run.

THE SAFEGUARDING OF LIFE IN THEATERS.

In our last issue we made some reference to the paper read by President John R. Freeman of the American Society of Mechanical Engineers at the opening meeting. This paper, containing as it does the results of an extended series of experiments and investigations by a specialist of wide reputation, carries with it a considerable degree of authority, and the data presented and the suggestions made are therefore especially worthy of being put on record. The following is an abstract of this paper covering some of the chief points of interest.

The direct cause of the great loss of life in the theater disasters which have taken place in various cities at various times has been the outburst of flames and poisonous gases from the combustion on a stage crowded with scenery. The opening of a door in the rear of the stage, bringing an inrush of air, combined with the absence of suitable smoke vents over the stage, together cause an outburst of smoke from beneath the proscenium arch, and result in death by burning and suffocation to the spectators in the crowded gallery. There have been at least four great disasters of this kind, all of them of sickening proportions, and all of them caused by practically the same chain of circumstances. In 1876 at Conway's Theater in Brooklyn the scenery was set on fire and, by the opening of large doors in the rear of the stage, a blast of suffocating smoke was produced, killing about 300, all of whom were in the upper gallery. At the fire in Exeter, England, within five minutes 200 were killed, mostly in the upper gallery. In 1881 at the Ring Theater in Vienna with an audience of about 1,800 a large door in the rear of the stage was opened the minute the fire was discovered, letting in a blast of air that sent the flame through the proscenium arch. The iron curtain could not be lowered, special exit doors were found locked, and 450 were killed, mostly in the gallery. The Iroquois disaster in Chicago is too recent and well-known to require a detailed description.

The problem of protecting the audience in a theater from the effects of a fire on the stage is not one that requires any new knowledge or any investigation along lines not already understood by engineers. After the Vienna disaster a committee of the Austrian Society of Engineers was appointed to investigate this matter and the results of their investigations have been on record for a great many years. The main problem is to give prompt and certain vent to the smoke and suffocating gases elsewhere than through the proscenium arch.

The construction of the stage, arch, and scenery loft in a modern playhouse, as may be seen by looking at a cross section of any such structure, bears a remarkable resemblance to that which would be presented by taking a section through an ordinary open fire-place. The conditions would thus seem to be exceedingly favorable for creating a draft from the audience toward the stage, instead of in the contrary direction, providing an outlet is made at the top of the chimney-like loft for an escape for the hot gases. There seems to be some recognition of this fact in the minds of the men who framed the various regulations applying to theater construction in the various cities. For instance, the building law in the city of New York reads as follows: "There shall be provided over the stage metal sky-lights of a combined area of at least one-eighth of the stage, fitted with sliding sash and glazed with double thick sheet glass, . . . the whole of which skylight will be so constructed as to open instantly on the cutting or burning of a hempen cord. . . . Immediately underneath the glass skylight there shall be wire netting, etc., etc." The ratio of smoke vent area to stage area given in this extract from the building laws is about that usually used in proportioning the area of the chimney and fire-place opening and agrees very well with the Vienna experiments and the practice which has been found desirable in England and other places where this matter has received attention. There are, however, a few almost criminally dangerous points about this New York law. The evident purpose of the thin glass is to cover the opening with something that will break out under heat if the mechanism for sliding off the cover fails. The wire netting is to prevent any pieces of broken glass from falling to the stage. This requirement as to the glass is well meant but it would be too slow in breaking out. Unconsciousness and suffocation come very quickly in an atmosphere of smoke. The wire netting is a positive danger as often applied. The Austrian experiments demonstrated that the force of the upward draft caused by the fire on the opening of the smoke vents, carries with it large pieces of flying scenery and other debris which lodge against the screen and almost entirely close the opening. This provision is one that should be changed at once. On Pres. Freeman's visit to the remodeled Iroquois he found the opening in their new vent shaft screened in a way that would, possibly in a minute's time, put them into a condition of uselessness.

Another dangerous provision is the use of a hempen cord instead of a fusible link for holding the skylight closed. There is no good reason to expect that a hempen cord in this position, in smoking atmosphere from which the oxygen has been largely removed, will burn off until a majority of those in the gallery have been suffocated. Fusible links have been in common use on automatic fire shutters in factories for nearly twenty years. It is almost beyond belief how slowly and scantily these have found their way into the fire protection of theaters.

Not only are the laws relating to this subject badly framed but they have in many cases been executed with a carelessness that is really criminal. In one of the newest and best theaters of New York the speaker found the ventilator with a broad sheet of heavy canvas laced tightly across its opening with marline. As the stage carpenter remarked, the cracks around the ventilator let in too much cold air. No building inspector had objected and the carpenter could not be made to see any danger. "It would burn off in any bad fire," he stated. So it may, but not until those in the gallery are mostly dead.

Concerning the design of smoke vents, there are practically none in actual use which have been designed intelligently and with a full consideration of the importance of details. The fundamental requirements are: Absolute certainty of opening by force of gravity in spite of neglect, rust, dirt, frost, snow or expansion by heat, twisting or warping of frame work. Quickness of opening to be secured by automatic links of improved design and by hand control from the prompter's stand and the station of the stage fire guard. The operative mechanism should be simple and massive, built more like rolling mill machinery than in accordance with watchmaker's practice. The poise weights should give a constant tension of 25 pounds or more on the release cord. The vent should be of such form that it can be tested daily by partially opening it and closing it again, preferably by means of the cord running to the prompter's stand. It should not be so loosely fitting as to let in cold drafts to tempt the stage hands to fill up the opening beneath it. Mr. Freeman presented designs for two types of ventilators, one with hinged shutters, the other with sliding shutters, both designed to meet the requirements outlined above.

The second requirement that should be introduced is the use of a well designed and freely acting fireproof curtain. Most theaters outside of Chicago at the present time are furnished with a fire curtain made from heavy canvas woven from asbestos fiber. For some time after the Iroquois fire there was some doubt as to whether the curtain in that theater was really made of asbestos, as its owners claimed. It fell as mere rubbish to the stage and outwardly little resembled the material of which it was supposed to be made. This curtain was an utter failure in three different ways. It could not be lowered, and stuck fast after passing a distance variously estimated at from one-fourth to one-half the height of the arch. The curtain was improperly hung, being supported at the top in part by being clamped between thin strips of pine wood about four inches wide by three-fourth high. These asbestos curtains in many theaters to-day are hung from a batten of white pine to which they are nailed across the top. When subjected to actual fire the Iroquois asbestos curtain lost its strength and fibrous quality almost completely and became so brittle that it was incapable of standing the pressure of a strong draft of air and was too weak to hang under its own weight.

This last defect is the serious defect of asbestos as a material for a fireproof curtain. Through various channels Mr. Freeman obtained samples from three feet to six feet square from all prominent American manufacturers of theater curtains and asbestos cloth. He also cabled to London and had a competent architect collect samples of asbestos curtain cloth from leading manufacturers and dealers, with instructions to use every effort to procure canvas woven from French or Italian, or other than Canadian fiber. When hard pressed for the pedigree of their samples none of these makers would furnish the canvas under a guarantee that it was made from anything other than the Canadian fiber, and the chemical analysis confirmed the belief that this was the only material used.

There are two or three minerals which go under the name of asbestos. The Canadian fiber is chrysotile. This is the common asbestos of commerce and possesses in a greater degree than the others the properties required for spinning and weaving. Themolite and a third material called anthophyllite, of which no great quantity has been found, are obtained from Georgia, Siberia, and South Africa. They resist heat to a very much greater degree than the Canadian fiber, which loses its strength at about 660 degrees Centigrade, but they are for the most part too brittle for spinning.

Three series of tests were made to determine the fitness of asbestos as a material for a fireproof curtain. The first of these was undertaken by Prof. Fuller, of the Massachusetts Institute of Technology, and was made with a degree of attention to details which renders the conclusions arrived at of very great importance. It was found that every one of these specimens of asbestos canvas, English and American alike, when heated from two to five minutes a little below redness in a common gas flame, or barely to redness in the Bunsen flame, lost 60 to 90 per cent of their strength and the fiber became very brittle. The samples which had interwoven brass wires were no stronger than the other samples, and on cooling they regained little of the strength due to the wire.

A second series of tests was made at the Underwriter's laboratory in Chicago on curtains about 6 feet square. On account of defects in the furnace this test was inconclusive. In the third series of tests Professors Crosby and Warren, of the Massachusetts Institute of Technology, made an exhaustive search through the extensive cabinets of the Institute and of the Boston Society of Natural History in the hope of finding specimens from some locality that possessed all the qualities commonly attributed to asbestos. The result of this search, in brief, was that nothing was found possessing characteristics materially different from the hydrous Canadian fiber on the

one hand, and the anhydrous fiber from Georgia on the other. Those of the first class lost their strength at a heat which drove the water off; the second class were too stiff or brittle to allow their use in a fabric.

In the Chicago tests there were tried different combinations of asbestos, asbestos felt, asbestic cement with thin steel plates and combined with wire netting, the asbestos being placed on the stage side in the hope that it might shield the steel plate curtain from the action of the fire and thus prevent the heating of the steel to redness and the consequent disturbance of the audience. It is plain to all who witnessed these tests that the steel curtain protected with some asbestos material on the fire side possessed far greater strength and endurance against fire than the simple asbestos. The general type of steel proscenium curtain finally adopted in Chicago and required at all theaters, was worked out somewhat hurriedly. The curtain with the framework for supporting it weighs from two to six tons. The handling would be improved by more substantial iron channnels to hold the edge, and by the addition of positive down-haul tackle or some arrangement by which the weight could be thrown off, for now the great weight of these curtains is so nearly counterpoised that conceivably the air pressure against this surface of about 1,000 square feet might prevent the slight excess of gravity from lowering it.

The question of fireproofing scenery was also investigated and in this matter also extensivė tests were made by men thoroughly competent in the matter, and consultations were held with several experienced scenic artists, and the conclusion arrived at was that the best possible in this line is far from satisfactory. The petty tests that have long satisfied several distinguished chemists are very misleading as guides as to what may happen on a larger practical scale, and the best we can hope to accomplish is to flame-proof a fabric so that it will not ignite from a match or electric spark or a gas jet, or so that, if ignited, it will not burst into flame. After investigating this question Mr. Freeman is of the opinion that we must after all rely on the safeguards of the engineer rather than those of the chemist. Disappointing conclusions resulted also from the investigations into fireproof woods and fireproof paints.

Perhaps the most interesting of all the experimental results recorded in this paper are those which relate to the composition of the chemicals contained in the various dry-powder and liquid fire extinguishers on the market. It is scarcely necessary to do more than call attention to the accompanying tables, which are compiled from the results of analyses made by reputable chemists on all the different varieties of extinguishers that could be found in the open market in and about New York. It will be noticed that the composition sold under the name of "Kilfyre," of which there were several tubes on and about the stage of the Iroquois, is composed almost entirely of bi-carbonate of soda or "salaratus," as the cook calls it. This, in the form and quantity in which it is found in the tubes, could be bought for about 10 cents; the extinguishers are sold at retail for as high as $3.00 apiece. Practically all these dry extinguishers are composed of common bi-carbonate of soda, frequently disguised by the mixture of cheap coloring matter like Venetian red. Possibly this material has some small value for a certain class of fires. Doubtless it is wise to carry a few tubes of this on an automobile. Doubtless in confined situations the bi-carbonate powder may sometimes do remarkably well, but it should never be used to give a full sense of security about the stage of a theater. Underwriters do not accept it in factory fire protection. They recommend that it be thrown into the rubbish heap. Pails of water are far more reliable. In general the materials of which all these extinguishers are composed render them of doubtful value on the smallest fire and entirely worthless for a fire with full ventilation. On the other hand, soda-water fire extinguishers consisting of a copper cylinder containing two, three or four gallons of a strong solution of bi-carbonate of soda, with a bottle of acid at the top so arranged that it can be upset into the soda and water, there-

ANALYSES OF THE CONTENTS OF HAND GRENADES.

Hayward Hand Grenade:	
Common salt	22.3%
Other solids	0.4%
Total	22.7%
Harden Hand Grenade:	
Common salt	18.5%
Salammoniac	6.7%
Total	25.2%
Babcock Hand Grenade:	
Common salt	21.2%
Chloride of Calcium	6.5%
Total	27.7%

TABLE SHOWING RESULTS OF ANALYSES OF DRY POWDER FIRE EXTINGUISHERS.

Price.	Name of Extinguisher.	Per cents of Chemicals by Weight. Bi-carb. Soda.	Red Ocher.	Yellow Ocher (or Iron Ore).	Fuller's Earth.	Common Salt.	Amm. Carb.	Sodium Phosphate.	Nitrate Soda.	Char-coal.	Fire Clay.	Sodium Sulphate.
	"Kilfyre"	97.5	2.5	....	....	....	....	....	....	....	....	....
$3.00	"	96.0	4.0	....	....	....	...	....	....	....	....	....
3.00	"Kingfyre"	97.4	2.6	....	....	....	....	....	....	....	....	....
3.00	Fyncide	99.5	0.5	....	....	....	....	....	....	....	....	. ..
	"Fore Dust"	94.8	...	5.2	....	....	....	....	....	....	....	....
3.00	"Improved"	87.6	...	12.4	...	....	....	....	....	..	....	....
3.00	Atomized	95.0	...	5.0	....	....	....	....	....	....	....	....
0.75	Driggs	89.5	...	...	10.5	....	....	....	....	....	....	....
3.00	Pan-American	30.6	...	37.9	....	7.4	2.3	8.1	....	....	....	12.9
3.00	Phenix	81.2	...	4.0	....	....	....	....	....	...	14.8	....
3.00	"	82.1	...	17.9	....	....	....	....	....	....	....	....
3.00	Manville	95.5	...	1.2	....	....	....	....	2.6	0.7	....	....
3.00	"	96.0	...	4.0	....	....	....	....	....	....	....	....

Another series of analyses ran as follows:

		Na_2O Soda.	CO_2 Carb. Acid.	Insol. Matter (Iron Ore).	Water in Bi-carb. by diff.	$NaCl$ Common Salt.	NH_3 Ammonia.					Na_2SO_4 Sodium Sulphate.	Starch.
$2.50	Kilfyre	35.4	50.6	4.0	10.0	....	....	....	....	....	....	....	....
....	Monarch	....	....	....	....	....	....	....	....	....	....	....	....
3.00	Pan-American	15.3	20.3	41.1	14.1	6.7	0.4	....	....	....	....	2.0	....
1.00	Eclipse	32.6	43.2	3.4	12.0	....	....	....	....	....	...	....	8.8
2.00	Manville	35.0	48.0	4.0	13.0	....	...	....	....	...	....	...	....
3.00	Phenix	30.1	41.8	17.8	10.1	....	....	....	....	....	....	....	....

Another series:

		Bi-carb Soda.	Mono-carb. Soda.	Iron Oxide.	Insol. Dust.	Loss at Red Heat.	Amm. Carb.	Common Salt.	Sodium Sulphate.	Insol. Iron Ore.	Water, etc.	Starch.	Clay.
.....	Monarch	93.7	2.4	3.8	....	35.7%	....	....	....	....	....	....	....
.....	Fyricide	94.7	4.6	0.7	....	36.8%	....	....	....	....	....	....	..
.....	Pan-American	34.5	4.4	....	....	....	1.1	6.7	2.0	41.1	10.2	...	....
.....	Eclipse	87.9	....	....	....	....	....	....	....	....	....	8.8	3.3
.....	Kilfyre	96.5	....	....	3.5	....	....	....	....	....	....	....	....
.....	Swan	97.2	1.7	....	1.0	....	....	...	....	....	....	....	....

by generating a strong pressure by the evolution of carbonic acid gas, are excellent for many places where pails would be unsightly.

The accompanying table containing the analysis for the contents of three makes of hand grenades purchased in the open market is fully as interesting as the one relating to the dry powder. The materials are inert and their only advantage over plain water is that they do not freeze at ordinary winter temperatures.

After everything possible has been done to prevent the starting of a fire in a playhouse and to keep it within the bounds of the stage after it has been started, there still remains the exceedingly important question of furnishing a safe and free means of escape to the audience, above all to those in the upper galleries. A type of fire escape has been developed under the building laws of Philadelphia, primarily for use in factories, which is so remarkably efficient and so far ahead in point of safety of anything that exists elsewhere, that it is a wonder it has not been copied in other cities. It is somewhat expensive, but the safety it gives is well worth the extra cost. The fundamental idea is that the stairway proper shall be absolutely cut off from the various rooms and floors which it serves. One must go out from the room into the open air and then enter the stairway. Once within this he can proceed without danger to the bottom. The total number of stairway exits and the total width of the stairway per hundred persons should be two or three times as great for the gallery as for the other parts of the house, and all exits should run in such a direct and obvious course that a person once in them could not fail to find his way to the bottom, even in total darkness. A sad loss of many lives occurred in the Iroquois by reason of a blind passage way from the gallery which led nowhere in particular, but extended out from the main exits in such a way that those rushing downward naturally took it as the line of escape, and a mass of women and children were caught in this *cul de sac* and doomed to suffocation.

THE TURBINE-DRIVEN CUNARD LINER.

Abstracts from Article in London Engineering, Dec 1. 1905.

The *Carmania* was built and equipped by Messrs. John Brown & Co., Ltd., Clydebank. This vessel is one of the seven or eight largest of the world's ships, having the following dimensions: length between perpendiculars, 650 feet; length over all, 672 feet, 6 inches; breadth, moulded, 72 feet; depth, moulded, 52 feet; gross register tonnage, 19,524 tons; draft, in working condition, 33 feet, 3¼ inches; displacement at this draft, 30,918 tons. She was designed for a speed of 19 knots. adoption of the turbine system of about 5 per cent. The boiler pressure in the *Coronia* is 210 pounds, and in the *Carmania* 195 pounds per square inch. The turbines take steam at an initial pressure of about 150 pounds as against 200 pounds in quadruple expansion engines. Another feature in the comparison which may be mentioned is that owing to the high vacuum desirable in the turbine system to insure the fullest economy the cooling surface of the condenser is increased in the *Carmania* about 20 per cent while the capacity of the centrifugal pumps is about double, so that the amount of circulating water discharged is from 50 to 60 times the weight of feed water, as compared with a ratio of 25 to 30 times in the *Coronia's* installation.

It was decided as a preliminary to the design and construction of the *Carmania's* machinery to make a set of three-screw marine turbines capable of developing about 1,800 horse power to be erected on land for experimental purposes. They were fitted with powerful dynamometers and with means for measuring the end thrust which in actual working conditions is balanced by the thrust of the propellers. Exhaustive trials were conducted under all possible conditions, the steam consumption measured, the relation of the ahead and astern turbines determined, etc. Finally, the turbines of the *Carmania* were designed with their proportions based upon the results of these experiments.

A striking feature of the turbines as erected in the engine room of the vessel is the lifting arrangement provided for removing the top half of the casing of each unit for examination of the blades. There are vertical screws for this purpose located permanently and driven by motors. These screws rotate in nuts bolted to the casing. The whole arrangement is a permanent and well constructed detail of equipment.

In normal working conditions the regulating valves admit steam to the high-pressure turbine and the steam passes through it to the low-pressure turbines and thence to the condenser. For maneuvering purposes a large, non-return valve, worked by a steam and hydraulic engine controlled from the starting platform, closes the connection between the high-pressure and each low-pressure turbine. This valve will close automatically as soon as a prescribed pressure is obtained in the low-pressure casing. Each of the low-pressure turbines is then manipulated as an independent unit. Special maneuvering valves are fitted to each of the low-pressure and astern turbines which allow of steam being admitted to either the ahead or astern turbines by a single movement of a hand lever. The turbine is fitted with a governor which operates when there is any marked increase in the number of revolutions.

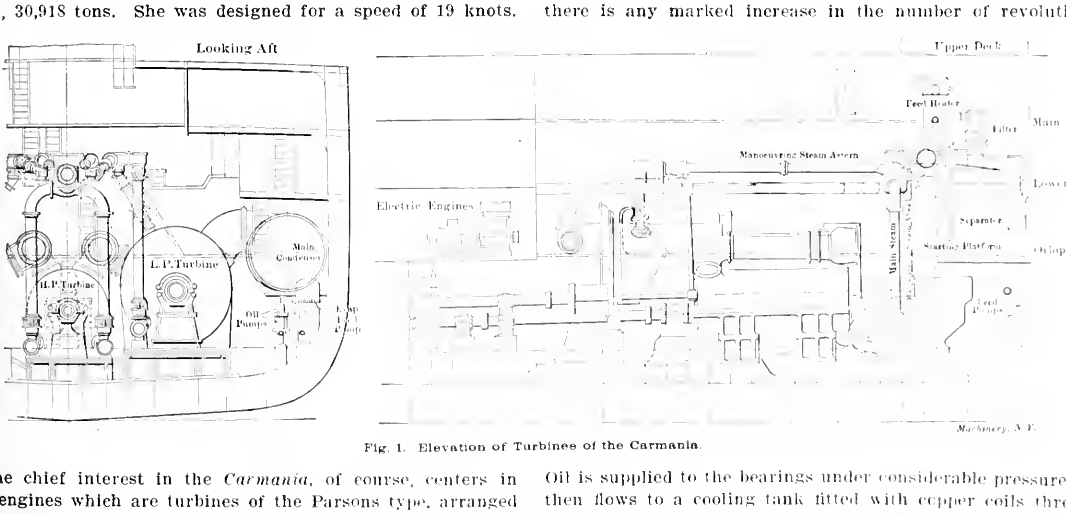


Fig. 1. Elevation of Turbines of the Carmania.

The chief interest in the *Carmania*, of course, centers in her engines which are turbines of the Parsons type, arranged in the usual manner with the high-pressure turbine on the center screw shaft and with one low-pressure turbine on each of the outside shafts. The area occupied by the turbine and auxiliaries is practically the same as required for the quadruple-expansion reciprocating engines of the sistership *Coronia*, built some time previously. The head room is less, however. The arrangement of the turbines and auxiliaries is shown in Figs. 1 and 2. There is a saving in weight by the

Oil is supplied to the bearings under considerable pressure. It then flows to a cooling tank fitted with copper coils through which water is circulated and after passing through a system of oil filters is again delivered to the bearings.

The Turbine Glands.

The gland for the shaft passing through the end of the turbine is rendered steam-tight by means of an improved design shown in Fig. 3. In the Parsons marine turbine of smaller sizes the leakage of steam from the high-pressure turbine and the ingress of air into the low-pressure turbine has been pre-

vented by the Parsons ring-and-groove type of gland. This gland consists of a series of grooves turned in the spindles into which bronze rings are fitted, the whole rotating in a truly bored cylindrical gland. When the difference in pressure between the inside of the turbine and the atmosphere is great the side pressure of these rings is very considerable and in order to distribute this pressure as equally as possible an ingenious method is adopted of arranging the rings in several groups and grading the pressure to each group by suitable connections. (Fig. 4.)

The builders realizing that the vacuum obtained depended mainly on the tightness of the low-pressure glands conducted an extensive series of experiments by means of a specially constructed apparatus which enabled dummy glands to be rotated under the same conditions that would obtain in practice.

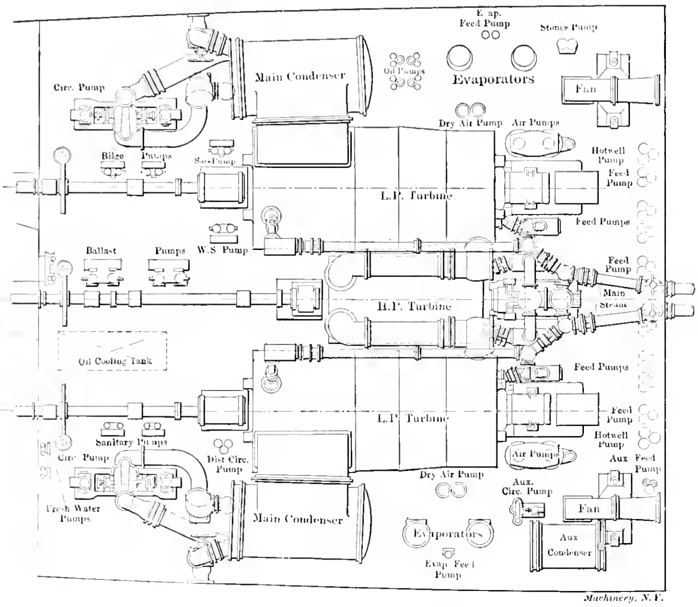
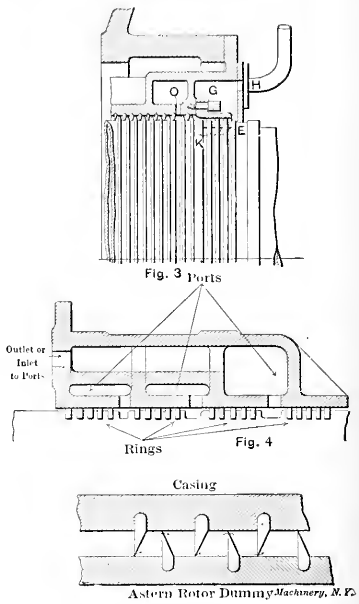


Fig. 2. Plan of Turbines of the Carmania.



Figs. 3 to 5. Gland Packing.

The size of these glands was the same as was to be used in the turbines of the *Carmania*. At first the regular Parsons ring-and-groove type was tried. The diameter of the gland was so large, however, and the speeds were so high that the rings gave unsatisfactory results, wearing rapidly. Examination of the scored surfaces led to the conclusion that the difference in pressure between the successive groups of rings was too great and an introduction of more groups to reduce this pressure would have led to serious complications; but after further experiments it was found that the desired result could be readily obtained by the adoption of radial fins, as shown in Fig. 5. The action of these fins is to alternately wire-draw and expand the steam, each pair constituting an expansion stage, thus reducing its pressure as it travels outward. The actual gland was fitted at each end of both the high- and low-pressure turbines, as illustrated in Fig. 3, with four rings, *K*, at the outer end. The small amount of steam which is allowed to leak past them for the purpose of lubrication collects in pocket *G*, whence it is led by the pipe *H* to the auxiliary condenser or exhaust tank. In the case of the high-pressure turbine, where the radial fins do not sufficiently reduce the pressure of the escaping steam, the pocket *O* is connected to an expansion row in the low-pressure turbine.

It is of the utmost importance in the practical working of a large marine turbine that means should be provided for determining the pressures at different stages of expansion; and what is of more importance, for ascertaining that everything is running satisfactorily inside the casing. To accomplish this a valve box is connected by pipes leading to the several stages of the turbine, each pipe running to a separate chamber in the valve box in which is a valve closed by a spring, but opened by a cam on a shaft that may be rotated by hand. There is a cam on each valve and as the valve is rotated the different cams come into action in succession, opening one valve after the other and admitting steam successively from the different chambers to one large chamber having a steam engine indicator attached. The indicator drum is given motion by a cord wound around a sheave on the shaft and during the rotation of the shaft, therefore, the pencil of the indicator traces a stepped line showing pressures existing in the different stages.

* * *

THE FEBRUARY DATA SHEET.

The table printed in the data sheet accompanying this issue of MACHINERY gives the number of sixty-fourths contained in all mixed numbers from 1/64 to 17 inclusive, varying by 1/64. Mr. Louis F. Lang, who contributed this table, uses it for adding fractions, as, for instance, when obtaining the over all dimensions of a piece by adding together the detail dimensions. Suppose we desire to make the following addition:

$$2\ 19/64 + 1\ 17/32 + 3\ 11/16 + 7\ 27/64$$

We find the number of sixty-fourths in each of these quantities by locating its integer in the row of heavy figures at the top of the table and then following that column down until it intersects with the horizontal row which contains the required fractional quantity in the left-hand column. Setting down the number given at this intersection for each quantity, and adding them together, we have:

$$147 + 98 + 236 + 475 = 956$$

This gives us the number of sixty-fourths contained in the sum desired. To express the result as an improper fraction we divide it by 64, thus:

$$956 \div 64 = 14\ 60/64 = 14\ 15/16 = \text{Ans.}$$

* * *

The conception of Dalton that an atom is a solid, indestructible, eternal, indivisible portion of matter has been modified by recent discoveries of science to such an extent that it may be regarded as obsolete. The amazing revelations of radioactive elements like radium have made a new conception of the nature of matter imperative. The new idea is that the atom is not necessarily indestructible but may be regarded merely as a sort of motion or a whirlpool in the ether. When this motion stops the atom ceases to exist. But however this may be, it is known that the atom is divisible, the smaller particles composing the atom being known as electrons. It is computed that a hydrogen atom contains about 800 electrons and that they are moving with a velocity of about 200,000 miles a second!

THE MANIPULATION OF HIGH-SPEED STEELS.

W. J. TODD.

The rapid progress of tool steel manufacture, and particularly the advent of high-speed steel makes it more and more necessary for the successful toolsmith to devote some of his spare time to a careful study of the nature and adaptability of new steels with special reference to their use in tool making. For, unlike the air-hardening steels of a few years ago, the high-speed steels of to-day can be used in innumerable ways for making tools which formerly were made only of carbon steel. The ease with which high-speed steel may be forged, shaped and hardened permits its use in the construction of many tools and dies. Hence, we not only find it in use in the machine shop for cutting tools, but in the press room for the construction of forming dies for hollow ware; also for wire-forming dies, and in the bolt mill for bolt heading dies on hot work. It is used for shearing dies for hot and cold bar work and for many various other purposes unthought of in connection with air-hardening steel. But, unfortunately, owing to the number of different makes of alloy steel now in use no standard rule can be adopted for manipulation. Therefore, in order to determine the proper forging and hardening heats it must be a matter of experiment for the toolsmith and he will find it a very good method to test the particular brand he is about to use by giving a piece of it as much heat as he thinks the steel can properly stand and noting the result.

The writer has found that a majority of the high-speed alloy steels should be heated whenever possible in block fire with a good body of forge coke. Thoroughly heat the steel in a clean bright fire to a full yellow plastic heat, which means a temperature of 1,650 to 1,850 degrees F. This, of course, is a much higher temperature than can safely be used in forging air-hardening or carbon steel. In fact, the heat treatment given alloy steels of the high-speed variety is so diametrically opposite to the generally accepted practice of working carbon steel that it seems to be a difficult matter to persuade the average smith to raise the heat to the proper temperature when working high-speed steels, but when this fact is once impressed, he will be surprised at the ease with which it can be worked. By rapid forging and repeated and thorough heating, it will be found no difficult matter to give alloy steel almost any desired shape, but, unlike carbon steels, it will not do to run the heat down low in forging, as in such practice the steel will most likely be found cracked or split. To heat thoroughly and often is the essential point to remember.

After forging alloy steel for lathe, planer and shaper tools, it is, of course, unnecessary to anneal them other than to let them cool down in the air in a dry place. When cold, rough grind to proper edge and then they are ready for hardening, which process will be described later. In making use of alloy steel for taps, reamers, twist drills, milling cutters, or forming dies, it will be necessary to anneal the forgings in order to enable them to be worked in the machine shop.

The different sizes and shapes of this steel can generally be procured already annealed from the steel maker, but when unable to obtain the annealed bar and the work is required to be annealed, proceed in the following manner: A very successful method of annealing high-speed steel, and also self-hardening steel, consists of placing the tool in a wrought-iron or cast-iron tube, having space large enough in circumference and length to accommodate the work and plenty of packing material. One end of the tube can be threaded for a cast-iron cap, which can be screwed on and off as desired; the other end can be permanently fixed on the tube, as it is generally only necessary to use the one end. Have a number of ¼-inch holes drilled in the tube, and also a few 3-16-inch holes in the end caps. The idea of the holes in the tube is to act as a vent and let off the gas which is generated from the packing material heating. The end holes can be used for a number of test wires, which can be withdrawn as the heating progresses, and by this means the operator will be able to ascertain the proper heat desired, which should be a bright orange or a trifle higher, according to the nature of the steel. When the desired heat is reached, regulate the blast sufficiently to hold the muffle and its contents at this heat for a period long enough to allow the heat to thoroughly penetrate the steel. Then the muffle with its contents may be buried in dry slaked lime, or sawdust and ashes, and allowed to cool down slowly. If a furnace is used for the heating, allow the muffle to stay in until furnace and all cools down, when the steel will be found quite easy to work in the machine. I would say, though, respecting this "dead heating" in the furnace, that unless the steel is properly packed in the muffle in order to exclude the oxygen blown into the furnace by the blast, the steel is apt to oxidize and the carbon content thereby become lowered, resulting in overannealed steel. The packing material used may be any one of several kinds now commonly used for other work, but charred leather gives the best results, and dry, fine smith coal of a good, clean quality is effective.

Now it is up to the machinist to finish to the desired shape. This he will find will be facilitated by using for a cutting tool a piece of the same steel, hardened. After he has accomplished his part of the work, it is then necessary to have the work hardened, which can be done in numerous ways according to the requirements desired for the tool. For turning and cutting tools for lathe, planer, shaper, and slotter, it will be found a good practice to heat the nose of the tool slowly to a bright red, then bring it rapidly with a good, quick fire to a white fusing heat, about 2,200 degrees F., on the point, then quench it quickly in oil and leave until it is cold. It must be borne in mind, however, that when a tool is at this high fusing heat it must not come in contact with the fuel of the fire, as, should that occur, the nose of the tool would be ruined and necessitate considerable grinding or reforging into shape. After regrinding the tool on a wet stone it will be ready for work and should give a good account of itself, and incidentally reflect credit on the smith who worked it.

The oil used may depend on how hard the tool is desired. We will suppose it is required dead hard on the cutting edges; this is as hard as it is possible to make it for machine shop use and still retain sufficient toughness. To obtain this result, after fusing the point or cutting edge quench quickly in thin lard oil, or for extreme hardness, quench the tool in kerosene oil, when about the limit of hardness in this steel may be obtained. In using oils, especially the kerosene, great care should be used or the oil may flame and burn the operator. The oil tanks used for hardening should be constructed preferably of galvanized iron, fitted with close-fitting covers, and provided with a screen a few inches from the bottom on which to rest the work in order to facilitate the quenching by allowing free circulation of the quenching bath to all parts of the tool.

In hardening machine finished work such as dies, milling cutters, taps, etc., made from this steel, we must proceed differently, as the course described would not answer for all purposes. All machine-finished work should be packed in muffles or iron boxes described in annealing, bringing the heat up in a similar manner, testing as also described. When heated sufficiently remove the cover of the muffle and quench the tool in a bath of oil, composed of half parts each of thin lard and raw linseed oils, keeping the tool in motion while in the bath until it has cooled to a little below the boiling point of the oil. Then it can be removed from the bath and left to cool in a warm, dry place, when, after being cleaned and polished, the temper may be drawn to a dark straw for general purposes. I may add that it is not always necessary to draw the temper on this character of tools; neither is it always necessary to harden such tools as milling cutters, dies, reamers, taps and drills in the oil. Very often it will be found only necessary to heat them to a good, bright red heat about 1,500 degrees F. and lay them in a cold blast; when cold they will be hard enough for ordinary work. The objectionable feature of the cold-air blast for such work is the liability of the steel to scale on the finished parts and possibly cause a slight loss in size, though this seldom occurs when proper care is used and the steel is not heated to a scaling point. The cold-air treatment, however, is applicable to work such as forming dies, wire dies and tools required to withstand some shock.

Sometimes it is unnecessary to pack the work as it may be successfully done by just using the tube and closing one end only. Place the tube in the fire and the work in it, bringing it to the required heat with a gentle blast and always keeping

the tube turning to insure an even heat and to prevent it burning.

In all instances the operator must exercise his best judgment in heating and quenching the tool according to its shape and the nature of the service required of it, but care must be exercised in selecting the steel when making tools of the high-speed steels to avoid getting a bar which may be "piped" or which contains "laps" or "cold shuts" formed in the ingot from bad teeming, or caused during the tilting. The density of its structure and the tendency of the alloys to segregate in the ingot makes it a difficult steel to manufacture of a sound and uniform quality. High-speed steel of high-grade quality is, therefore, necessarily high priced, but when the efficiency of its service is considered it is acknowledged the superior to high-carbon steel for every purpose where it can be used.

* * *

NOVEL BLUE PRINTING APPARATUS.

H. O. GARMAN.

The necessity for having some contrivance to hold a tracing or vandyke negative firmly against the sensitized blueprint paper or cloth, and at the same time to protect from the weather both the operator and his material during the time of exposure of the print, has given rise to many inventions. The different devices range from the simplest common hand frame to the varied and more or less complex blueprinting apparatus of the automatic type, and the price varies from the insignificant cost of the small hand frame on the one extreme, to as much as $500 to $600 for the larger and more complex machines. The cost of labor for printing is nearly inversely proportional to the number of prints that the frame will hold at a single exposure, provided the tracings or negatives are fastened together, the small separate sheet system of printing being very expensive. When several prints are

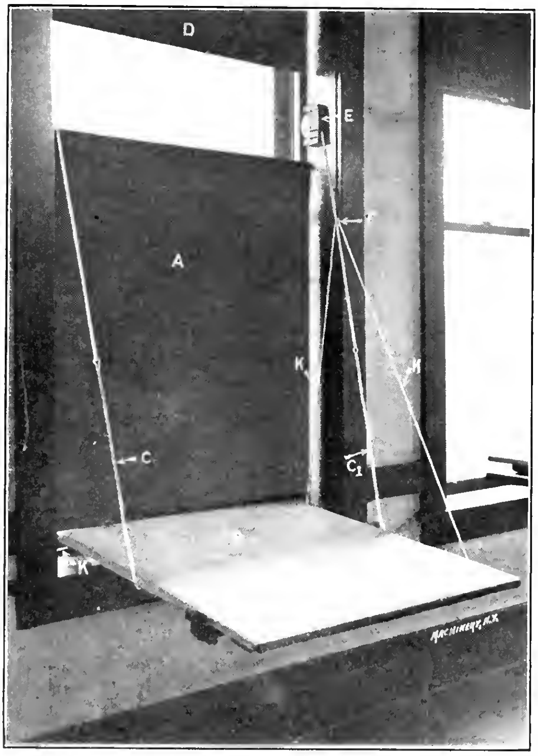


Fig. 1. Novel Blue Printing Frame.

made at one exposure no dark room is necessary, for a large piece of paper can be quickly placed in position, exposed and washed, and then cut apart in the full light at the leisure of the operator or during the time of exposure of another frame.

It is not the purpose of the writer to describe a machine which is better than some of the best machines we now have, but rather to describe a novel device for making both large and small prints, the design and cost of which brings it within the reach of any one having such work to do.

When one is called upon to make only an occasional small print it will be found that a small hand frame exposed directly to the sun's rays is the most economical method; but when the number of prints required increases beyond a certain limit

Fig. 2. Raising the Back into Place.

and when the size of prints exceeds say 2 by 3 feet or 3 by 4 feet, the hand frame, if substantially made, becomes very cumbersome. When prints are being made continually, as in a blueprinting establishment, the more complex electric machines are necessary, but in most places where drawings are being made there is not a continual demand for prints so that the cost of one of these machines would be a waste of capital; and too, it is not always convenient to obtain the electric current. In such case one is obliged to resort to the sun as a source of light and to some cheaper means for holding the tracings than is adopted in the special devices. The large hand frame must either be: (1) carried out of doors; (2) run out through an open window on a track; or (3) left lying on a table inside a closed window. The first method is exceedingly tiresome to the operator; the second allows a draft to enter the room and disturb papers, etc., and in winter time may endanger one's health from cold drafts; also the inside track design takes up too much space. Then too, both of these methods during rain storms endanger the tracings and negatives. The third method is expensive in that it demands a longer time of exposure, caused by the sun's rays having to pass through two thicknesses of glass at acute angles.

The blueprint frame to be described in this article is particularly applicable to use in the office of a consulting engineer, contractor, small railway division headquarters, etc. It has served a useful purpose in the blueprinting work done for the school of civil engineering in Purdue University. After considering all the points of economy both in the cost of apparatus and production of prints for such offices as just named (where, as already stated, the sun must generally be used as the source of light) a contrivance for exposing the sensitized paper to the sun should provide for the following features: (1) Minimum time of exposure; (2) protection of the trac-

ings while exposing; (3) ease of placing the prints in frame and exposing same; (4) protection of the operator from the weather; (5) no dark room for cutting paper; (6) least possible encroachment on inside space in office.

The requirements are: (1) A south window; (2) a drawing board the size of the window glass; (3) a supply of heavy table padding and cotton batting; (4) two Pullman spring window counter-balances; (5) an ordinary roller window shade; (6) three hinges; (7) two spring catches; and (8) some strong cord. It is not necessary to purchase a glass of any kind, since the regular window glass is used. See Figs. 1 and 2.

Cut one piece of the table padding large enough to cover the board, with surplus to allow tacking to the side. Cut the remaining piece of padding into four other rectangles, each being made smaller than the preceding. Place the pad rectangles concentrically on the board, then cover uniformly with cotton batting and over this place the largest piece of pad mentioned above, the same being tacked to the sides of the board when well stretched. This gives pyramidal or convex form of cushion which insures a uniform pressure against all parts of the window glass, the elasticity of the glass allowing it to bulge into this form. Experience shows that the window glass should be held in place with screws and wooden strips, putty not being strong enough to permanently stand the pressure. Next, place the padded board in the window and attach the hinges to the lower side of the board and to the bottom sash bar; attach the spring catches on the top sash or on the side sashes near the top. This holds the board firmly in place. The balancing apparatus, consisting of the two Pullman spring counterbalances, are attached one on each window casing about opposite or a few inches above the top sash, the suspenders being attached to the board on each side at such a point between the top end and the hinge as to produce equilibrium. The roller window shade is fastened to the casings about 4 inches above the top end of the board an inch from the sash, and both of its catches removed, making it possible to run up or down without interference. The shade is operated automatically as the board is raised and lowered, thus shutting out the light when the board is horizontal and the sensitized

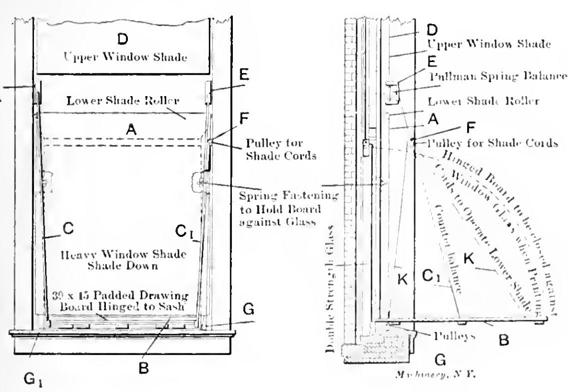


Fig. 3. Details of Board, Method of Suspension, etc.

paper is being inserted, and runs up out of the way as the board is raised to a vertical position against the window for printing. The cord operating the curtain passes down from its two lower corners through two pulleys in the window sill where one cord passes along the bottom sash to the other pulley. Here both cords ascend together to a third pulley on the casing where they both again descend a short distance and are attached to the board. The position of the third pulley on the casing and also the point of attachment to the board must be adjusted so that the cord distance from this pulley to the point of attachment when the board is in a horizontal position is equal to the distance the shade must travel down to shut out the light. When printing, the regular shade is drawn to where the other roller is attached, thus shutting out the light from the upper window.

When not in use the hinge pins may be drawn, the suspenders and shade cords unhooked and the board removed, leaving the window entirely unobstructed and no floor space occupied. If but one print of a tracing is wanted, fasten the tracing on top of the sensitized paper by putting at each corner a common pin through both and into the padded board. When the board is pressed against the window it will hold the tracing smoothly and firmly against the paper.

When a considerable number of prints are to be made from one tracing this apparatus is exceptionally rapid. Take four pieces of chamois, ½ by 1½ inches, at one end of which are attached two or three small rubber bands looped together. Pin one of these pieces to each of the corners of the tracing and draw the rubber bands over the edges of the board and hook them over the heads of brass tacks placed along the edge of the board on the back side. Then to make any number of prints cut the paper to size and slip it under the tracing, raise the board against the glass, expose a sufficient interval, then drop the board, draw the paper out, and wash it. With this arrangement, using fast paper and good sun light, one large print every 70 seconds has been made. If working during a heavy rain storm the tracings are protected from water, everything about the apparatus being inside the room.

The writer has also found it very convenient and economical when making prints from drawings on ordinary paper such as pamphlet leaves and from vandyke negatives to saturate them uniformly with oil of vaseline, blancholine, or glycerine, making sure to rub off any surplus oil which might soak into the blueprint paper during the time of printing and thus prevent it from washing. This process makes it possible to obtain blueprints from most any cut or drawing without the extra cost of first having it traced, it also makes the slow vandyke negative print in about one-third of the usual time.

To place notes in a permanent and convenient form for blue-printing have them typewritten (leaving such spaces as may be necessary for figures which will be drawn in afterward) on a thin strong transparent paper with a carbon on its back thus making the letters dense. To prevent the carbon from rubbing off use an atomizer and blow on it a shellac fixitive used for fixing charcoal drawings. When the fixitive is dry, oil the sheets as described above and they are ready for printing.

The following statement of the costs of apparatus to take a 3 by 4-foot tracing includes that just described and the ordinary blueprint frame, together with the high-priced appliances.

(1) One of the best electric machines (listed)	$500.00
(2) Vacuum sun frame (listed)	75.00
(3) Felt cushion sun frame (listed)	80.00
(4) Apparatus above described	6.87
The last named is itemized as follows:	
1 Drawing board	$1.75
2 Pullman spring window counterbalances at 82½ cents	1.65
2 yards of table padding at 70 cents	1.40
1 window shade with mountings	1.20
3 pairs hinges at 10 cents	0.30
3 pulleys at 5 cents	0.15
2 spring catches at 10 cents	0.20
1 roll cotton batting	0.12
12 feet of strong cord	0.10
Total	$6.87

To summarize, the device here described has the following advantages: (1) It is adapted to offices requiring a moderate amount of blueprinting, and where the more costly appliances cannot be afforded for lack of either means or space; (2) notwithstanding the large size of the board the counterbalancing device enables one to insert and remove the materials easily, with no annoyance in raising or lowering a large window; (3) minimum time of exposure and the protection of the tracings and operator from weather; (4) no dark room or boxes required to cut the small pieces of paper, but several tracings being printed on the full width of the roll and then cut apart in the full light after the prints have been dried.

* * *

William Koenig, the proprietor of a brass finishing shop in Brooklyn, was killed by the bursting of a new emery wheel which he was showing off to his workmen; he was struck in the chest by a large piece of the wheel and six of the workmen were seriously injured.

PRACTICAL DONT'S FOR MACHINISTS.—3.

H. E. WOOD

Don't blow into a hole that has dirt at the end of it.

Don't be afraid to tell your new ideas to your foreman.

Don't finger a piece of work while filing it in a lathe.

Don't use the side of your hammer to drive anything with.

Don't think all machinists are worth the same rate of pay.

Don't take advantage of your foreman's absence to "cut up."

Don't use a hollow-backed chisel for cutting oil channels.

Don't use a fine pair of dividers on rough and sandy scale.

Don't forget that O. K. means "Oll Korreckt," or all correct.

Don't try to grind a plug valve to a seat with coarse emery.

Don't try to make a flat surface with the tip end of a file.

Don't think that a farmer boy cannot learn to be a machinist.

Don't file a piece of work when it chatters beneath your file.

Don't use a hard hammer to drive a mandrel into a piece of work.

Don't stop your machine while in the midst of a finishing cut.

Don't cut a rawhide gear on slow speed, as a fast speed is much better.

Don't gage the amount of work you do by the amount of pay you receive.

Don't mark fine tools with steel letters—squares and scales especially.

Don't forget that large pieces of cast iron may be bent by peening them.

Don't throw away all the short butt ends, when you are cutting up stock.

Don't bore out the lathe chuck when you are boring a piece of work in it.

Don't put a lot of "gingerbread" polish on work that does not require it.

Don't set a tool to take a finishing cut, without using an oilstone on it.

Don't try to rough out and finish large screw threads with the same tool.

Don't fit a bracket on a machine and leave its bolting surface crowning.

Don't think that what you know about a machine nobody else can find out.

Don't forget that your fingers are softer than gears, or iron of any kind.

Don't forget that the closer you can get your toolrest to the work, the better it is.

Don't make a piece of work to a blueprint and have it look like something else.

Don't forget that the warmth of your hand will increase the diameter of a shaft.

Don't mark machine part numbers bottom side up, when you are erecting a machine.

Don't build a machine with castings that have molding sand still sticking to them.

Don't drive a key into place unless you have some means of getting it out again.

Don't grind a tool to cut machinery steel the same shape as you would to cut tool steel.

Don't carry dirty tools back to the store room, for the storekeeper to clean off.

Don't use a long neck planer tool, when you can get at your work with a short one.

Don't serve an apprenticeship without learning to dress and temper your own tools.

Don't forget that a universal lathe chuck should be tightened at all of its screws.

Don't start up the engine without letting off the condensed steam in the cylinders.

Don't boast that you can grind a cutting tool of any kind better than anybody else.

Don't say "I don't think that is right because I never saw it done that way before."

Don't put greasy fingers on cast iron either before or while taking a finishing cut.

Don't leave a shop, without leaving a clear record, so you may come back to it again.

Don't forget to see that your cutting tool has clearance back from the cutting edge below the chip.

Don't squirt a tablespoonful or more out of an oil can to find out what kind of oil is in the can.

Don't take three or four stock (or roughing) cuts when you can take all of the stock off with one cut.

Don't believe that a man can learn the machinist trade thoroughly in one shop or in three years time.

Don't spit tobacco juice on the floor where the erecting man has to crawl around on his hands and knees.

Don't forget that the kind of oil used has a great deal to do with the working of a drill, tap, or reamer.

Don't say "there was not stock enough to finish up to size" after you have made a piece of work too small.

Don't forget that a lathe tool will make a brighter and smoother finish with water than it will if run dry.

Don't line up a shaft and pour babbitt bearings without making allowance for the sag in center and ends.

Don't use the tail end of your vise for a "chopping block" in cutting off sheet metal, etc., with a chisel.

Don't put a planer strap between your packing pieces, if you can possibly get it directly over the packing.

Don't get the "bighead" just because you can do a job or two, or if someone has told you that you are smart.

Don't forget that if a shaft gets to cutting, or is "froze," kerosene oil is the best thing to start it loose with.

Don't forget that a drill will make a hole larger than its own size when one lip is longer than the other one.

Don't start to turn up a job on lathe centers unless you know that the centers are both in line with the ways.

Don't tell the foreman that you are an all-around machinist, if you are only a specialist on one kind of work.

Don't put nuts on studs unless the thread is cut far enough down to allow the nut to go fully up to its place.

Don't ask for a "soft snap" running a machine when you can get a "good snap" running a hammer, chisel, and file.

Don't forget that you can handle a tailstock spindle faster with a wheel than you can with a cross-bar and handle.

Don't forget that paper, laid between two flat, smooth surfaces of iron, will help them wonderfully from sliding.

Don't run a machine reamer in a piece of work in the lathe chuck unless you know that the tail center is in line.

Don't say you have done all that can be done for a machine, when you have only done all that you know how to do.

Don't use a square to square up a tap unless you keep the stock flat down on the surface you want to square from.

Don't let a lathe or planer tool cut out into cast iron scale if you can possibly get under all of the scale with the first cut.

Don't forget that the machine you are running and the space you are occupying, have to be paid for just as well as *your* time.

Don't believe that lard oil is the only solution that is good to use on dies or tools in cutting threads, or wrought iron parts.

Don't bore a large steam engine cylinder when lying in a horizontal position if you can possibly do it in a vertical position.

Don't forget that where a thick and thin jamb-nut are used, the thin nut should go on next to the work and the thick one on top.

Don't get into the habit of trying every piece of work you make into the place it goes, but learn to depend upon your calipers.

Don't be content with knowing just what "shop kinks" you have learned from someone else, but investigate and work out a few yourself.

Don't file a shaft over a keyseat, in a lathe, if it is necessary to reduce the size; either take a cut with the lathe tool, or draw file it.

Don't forget, in tapping babbitt metal, lead, or any such soft stuff, to take the tap out and clean it after each full turn in.

Don't believe that a piece of work can be laid out, and drilled, planed, or milled as accurately as if it were done in the proper jig.

LETTERS UPON PRACTICAL SUBJECTS.

HOW I MADE DEEP-HOLE DRILLS TWENTY YEARS AGO.

Editor MACHINERY:

I was greatly interested in the article by E. W. Norton on deep-hole drills in October MACHINERY, and I think a little ancient history on this subject may be of interest to you.

In 1884 or 1885 E. G. Parkhurst, M. D. Pratt, J. E. Woodbridge and myself, with others, organized the Hartford Tool Co., primarily to manufacture patent lathe tools of various kinds. The "Gardner & Woodbridge" thread tool, now called the "Pratt & Whitney" thread tool, was my patent, and it was for work on this tool that I made the special drill which later developed to the "deep-hole" drill. About two years later the absorption of the Hartford Tool Co. by the Pratt & Whitney Co. threw me out of business and I went to work for Pratt & Whitney under Mr. Heyer, on the "reamer job"—then in its infancy. The company were making up a stock of standard reamers. The drilling, or chucking, of the blanks was being done on hand turret machines. It had been decided to fit up two large "Spencers," *i.e.*, Hartford automatic screw machines, for this work, when the job was turned over to me by Mr. Heyer.

The blanks for the reamers were round tool steel and, as I remember, were made from 1¼ inch diameter by 2¾ inches long with ½-inch taper hole, to 3½ inches diameter by 4½ inches long, with 1¾-inch taper hole. The machines were fitted with common universal chucks. The first consideration was to get a hole through the blanks from end to end without withdrawing the drill or stopping the feed. As is usually the case with any new idea or invention, it is impossible now for me to say just when or how it came into my mind, but

Fig. 1. Blank for Deep-hole Drill.

thinking of a single-lipped drill I had made for a difficult cut on thread tools, I thought of putting a smaller groove opposite the large groove, covering it with a dove-tailed strip of metal, and connecting the small covered groove with a hole through the center of the drill shank and forcing oil through the hole and covered groove to the cutting point of the drill. I had had experience with the cutting action of single-lipped drills on thread tool work and when I had gotten the oil groove and connections thought out I felt confident as to the success of the thing. I took the idea to Mr. Heyer and he said. "It looks good. Go ahead and try it out," or words to that effect.

I started in on the smallest blanks at hand, which were, as I recollect, for 1 inch reamers and about 3 inches long. The first drill I made was 7-16 inch diameter (See Fig. 1.) The dimensions are from memory and are not claimed to be exact. I milled the large or cutting groove with a standard twist drill cutter, giving it a little less than the regular spiral. The end view at cutting point was about like Fig. 2. Exactly opposite I milled a deep narrow groove, making the end look like Fig. 3; the spiral was the same on both grooves. The small groove was about 5-32 inch deep and of the same width. I then made a small shank cutter and under-cut the sides of the smaller groove to the shape shown in Fig. 4. The small groove was carried up further than the large one and a hole was drilled from the top end to connect with the hole through the center of the shank. I next beveled a strip of sheet metal—do not recollect whether it was steel or brass as I afterwards used both—and crowded it into the dove-tail, so covering the narrow groove. I then soldered the strip in very carefully and had a continuous oil-tight pipe or hole from shank end to the cutting point of the drill.

The drill just described was held in the turret in a plain collet with a set screw Fig 5. The collet was connected at the center of the turret with a pipe from an oil-pump. This pipe was provided with a swivel joint, allowing the turret to revolve. To support the drill when starting, that is, to hold it true to the center, I rigged a rest on the cross slide, Fig. 6 It was made of steel and hardened. It came up automatically and held the drill full up to the center until the lip was in, say 1-4 inch, and then moved back out of the way. I do not know how much pressure the oil-pump gave but it would throw oil six or eight feet horizontally from the point of the drill. I do not recollect a first starting or trying-out of any job with so many untried and experimental features that proved so complete a success as that one did. At the first trial that 7-16 inch drill simply "walked right through" the 3 inches of steel, and kept it up hour after hour; I will not attempt to state what the record was, but my recollection is

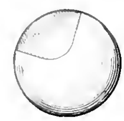


Fig. 2

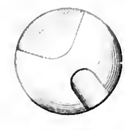


Fig 3.

Fig. 4

that more than one hundred pieces were bored without re-sharpening the drill. On this particular size of reamer blanks I used two other tools in the turret—a roughing drill, enlarging the holes to about ⅝ inch, and a taper reamer. The oil for these was applied through the spindle of the machine from the back end, being switched automatically from the turret.

The successful outcome of this first trial encouraged me to believe that I could go further with the same idea; particularly when the moderate pressure used on the oil had proved so efficient in ejecting the chips. I told Mr. Heyer that I would like to make a drill smaller in diameter and considerably longer, and as before, was told to go ahead and try it out.

I then made a drill, which according to my recollection was 5-16 inch diameter and about 12 inches long. It was made in the same way as the shorter drills used on the reamer job. To test this drill I selected a piece of round tool steel about 1¼ inch diameter and 10 or 11 inches long. One end was held in the chuck on an old style Pratt & Whitney 13 inch lathe and the other end ran in the center-rest. The drill was held in the tool-post on the carriage. I do not remember exactly what kind of a holder I used but it was a temporary rig. I compounded the feed gears to get a very fine feed, but cannot say now what the feed was; probably it was not more than

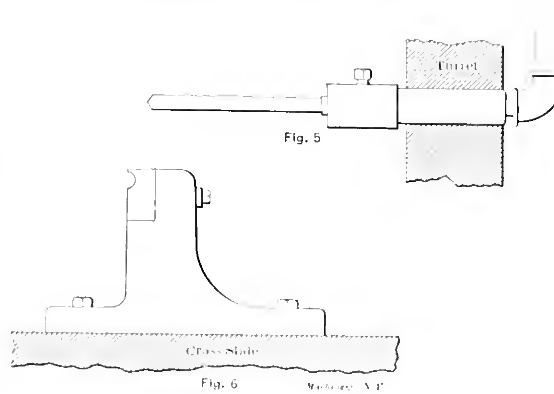


Fig. 5

Fig. 6

How the Drill was Used

0.002 to 0.003 inch per revolution. I put up a special countershaft to drive the oil-pump for "all that was in it." This pump was a small rotary affair but it did the work. I do not remember the details of this test so well as that of the reamer blanks. Neither can I say how the pump was connected to the drill—whether by a flexible hose or a telescoping pipe

I do not remember just how long it took to feed the drill through the bar, but I *do remember* that after the drill was started it went entirely through the bar without a hitch, and that it made a beautiful hole. Further, I remember making a shield by taking the nose and bottom out of a tin oiler and

sliding what was left onto the drill, the top towards the shank. This caught and stopped the stream of oil which, otherwise, would have soaked everything and everybody in the vicinity. I remember distinctly the satisfaction I felt at hearing the chips strike the tin shield as they came out with the oil. This experiment was considered a success without further trial, and orders were given to fit up a 16-inch gibbed lathe for drilling the hole through lathe spindles.

I made two more drills of the same type which were (again trusting to memory) 3-4 inch diameter, and about 36 inches long. Two toolmakers assisted me in fitting up the lathe. We had the work nearly completed and ready for trial when I left Hartford for Chicago to work as salesman for C. H. Besly & Co., who were then Pratt & Whitney's western agents.

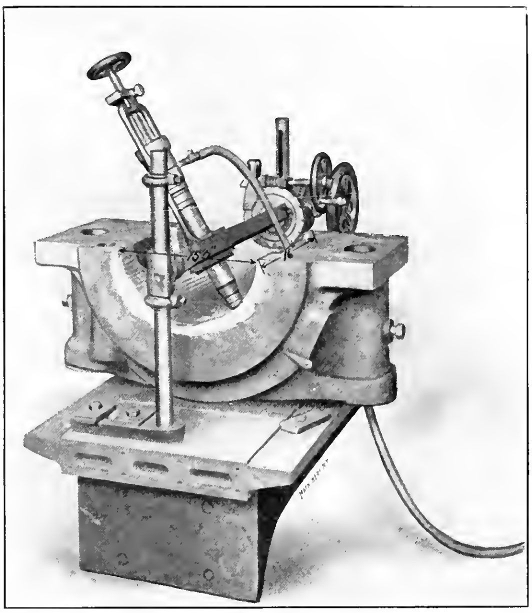
I am not familiar with the progress and development in the art of deep-hole drilling since then, but so far as I know this was the origin of the idea of forcing a liquid through the body of a drill for the purpose of cooling and lubricating the cutting point and forcibly removing the chips as fast as they were formed. Up to the point to which I carried it the idea was entirely new and original with me, and at that time I was recognized by the leading mechanics at Pratt & Whitney's as the inventor. If anyone can antedate me on the idea of "forcing oil in and chips out," I will accept the position of "also ran," but am willing to let the foregoing facts be published as a matter of history. F. N. GARDNER.

Beloit, Wis.

PNEUMATIC BABBITT BEATING MACHINE.

Editor MACHINERY:

The pneumatic babbitt beater, shown in the accompanying illustration, was designed and patented by Charles Hightower, late assistant superintendent of the Union Iron Works, of San Francisco, Cal. It will undoubtedly fill a long-felt want in the machine shop—not only from a practical standpoint, but from an economical one as well.



Pneumatic Hammer arranged for Beating Babbitt in Bearings.

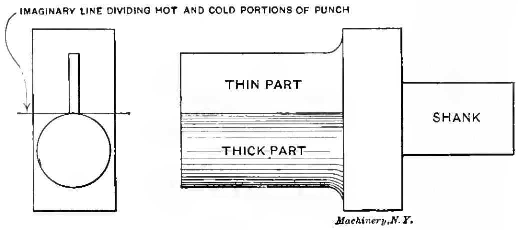
Beating babbitt by hand, as we all know, is very expensive and at the same time not altogether satisfactory. The job is usually done by one of the shop laborers, who does not understand the importance of properly beating the babbitt, until it is well into the dovetails provided for securing it in place, and at the same time closes up the pores of the metal, together with any possible blowholes that might have occurred in pouring, and to this fact may be traced a good deal of the trouble given by babbitted journals and surfaces. While the work done by the machine may also have its faults if the machine is not skillfully handled it will be seen that there is no comparison between the two methods of beating babbitt as far as the cost of production goes. The cap, shown in the illustration, is 16 inches long, with a bore of 15½ inches and it was beaten in nine minutes. The machine, as may be seen, is of very crude construction, having been built entirely for experimental purposes. As the principle is clearly shown in the cut, consisting of a suitable frame for holding and traversing a pneumatic hammer an explanation as to the construction and operation is hardly necessary; sufficient to say that it gives entire satisfaction and promises to be a welcome addition to the modern machine shop.

San Francisco, Cal. W. S. ATKINSON.

HARDENING WITHOUT CRACKING.

Editor MACHINERY:

I have a method of hardening intricate shapes without cracking that I desire to place before others. This method does not deal with special baths, special appliances to hold the work in proper position when dipping, gas furnaces, etc., but with the old-fashioned charcoal fire which the majority of us are obliged to use. These "special appliances" are of little value to us toolmakers who are confronted with "Use what appliances you have; do not rig up anything special." If my method of hardening is followed to the letter, there will be few cases of cracked dies. I have used charcoal fire and the following manner of hardening for the past twelve years and have yet to crack my first die.



Punch to be Hardened.

The first operation is heating. Do not prepare a die for fire by plugging up the screw holes with fire clay. For when the die becomes warm the water is evaporated from the fire clay, causing the clay to shrink away and allowing steam and hot water to get in between the clay and hole, thus raising more deviltry than if the hole had been left open for the water to flow freely through it. Place the article in the fire, with a slight draft blowing, and change its position frequently to insure uniform heating. Too much importance can not be attached to even heating, as this is the ground work of successful tempering. It should be borne in mind that steel expands nearly one-eighth inch to the foot when at bright heat. Therefore if one-half of a die is dark red and the other half is bright red, it is clear that one-half of the die has expanded more than the other half, thereby causing forces to push against each other. This condition tends to warp the die while it is hot. And if the die is dipped while in this state, as is too often done, there will be uneven contraction, causing internal strains, strongest along the line that divided the two shades of red, and causing a "set" in the die that holds it in a curved line caused by one end of the die expanding more than the other and pushing that end out of a true line.

Young fellows, follow carefully while I attempt to explain in my homely way what I have found to be the greatest cause of cracks when tempering. If you catch the point I am trying to make clear, you need have no fear when immersing an expensive die in the bath. For example, we will harden the punch, Fig. 2. We heat this punch carefully and evenly in a charcoal fire or gas furnace. For a bath we have a tub of clear water. The punch is removed from the fire the instant the proper heat is attained. We now immerse the punch in water, but do not allow water to remain at the same level on punch, as this causes either a crack or a huge swell, as will be shown later. Now place one hand down in the water and keep feeling of the punch. The moment that you can bear your fingers on the punch, remove it from the bath. Under no

consideration must you allow the punch to become cold in the bath, for this is just what causes cracks, for this reason: When we immersed the punch the slender stem was immediately attacked by the water, contracted to its normal size and became cold and hard, while the body of the punch was still red hot. This caused a distinct line between the hot and cold portions of the punch shown by the imaginary line in the cut. Now, as the body of the punch begins to cool and contract, it is obvious that it must certainly be pulling away from the stem, which is already contracted. If a crack does not appear, it is no sign that it will not sooner or later, as there certainly must be a tremendous internal stress which will crack the punch later, and the operator will be taken to task for his carelessness. But, on the other hand, if we remove the punch as soon as we can bear our fingers on it in the bath (when it is still so hot that it steams), then the heat from the body of the punch will run out into the slender portion and the contraction will be uniform, excepting for the little effect the atmosphere may have.

The above could be written in a very few words, thus: "To prevent dies cracking, do not allow them to become cold in the bath." FRANK E. SHAILOR.

Great Barrington, Mass.

DIMENSIONS OF EQUAL SECTION AND ECCENTRIC PISTON RINGS.

Editor MACHINERY:

The accompanying tables of equal section and eccentric piston rings are very useful to shop men and others; I have used them for some years, and know them to be right.

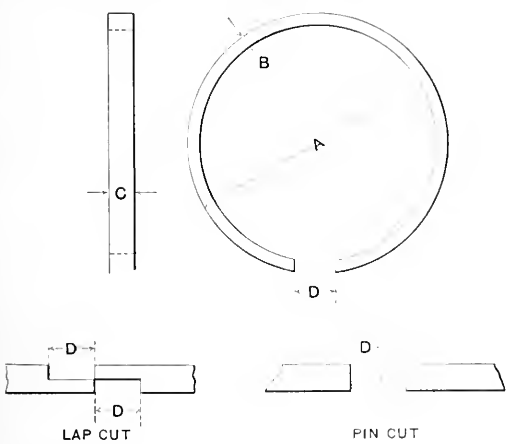


TABLE OF DIMENSIONS FOR EQUAL SECTION RINGS.

LETTERS	DIAMETERS, OF CYLINDERS, IN INCHES.														
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	$6\frac{5}{32}$	$7\frac{5}{32}$	$8\frac{3}{16}$	$9\frac{3}{16}$	$10\frac{7}{32}$	$11\frac{1}{4}$	$12\frac{1}{4}$	$13\frac{9}{32}$	$14\frac{9}{32}$	$15\frac{5}{16}$	$16\frac{11}{32}$	$17\frac{11}{32}$	18 [illegible]	$19\frac{13}{32}$	$20\frac{13}{32}$
B	$\frac{1}{4}$	$\frac{9}{32}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{13}{32}$	$\frac{7}{16}$	$\frac{15}{32}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{19}{32}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{16}$
C	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{13}{16}$
D	$\frac{35}{64}$	$\frac{39}{64}$	$\frac{21}{32}$	$\frac{23}{32}$	$\frac{25}{32}$	$\frac{27}{32}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{16}$	$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{1}{4}$	$1\frac{9}{32}$	$1\frac{11}{32}$

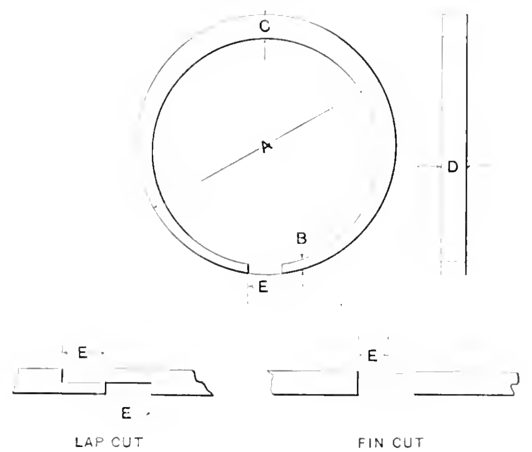


TABLE OF DIMENSIONS FOR ECCENTRIC RINGS.

LETTERS	DIAMETERS. OF CYLINDERS. IN INCHES.														
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	$6\frac{5}{32}$	$7\frac{5}{32}$	$8\frac{3}{16}$	$9\frac{3}{16}$	$10\frac{7}{32}$	$11\frac{1}{4}$	$12\frac{1}{4}$	13 [illegible]	$14\frac{9}{32}$	$15\frac{5}{16}$	$16\frac{11}{32}$	$17\frac{11}{32}$	18 [illegible]	$19\frac{13}{32}$	20 [illegible]
B	$\frac{3}{16}$	[illegible]	$\frac{1}{4}$	$\frac{9}{32}$	[illegible]	$\frac{5}{16}$	$\frac{11}{32}$	$\frac{3}{8}$	$\frac{13}{32}$	$\frac{7}{16}$	$\frac{15}{32}$	$\frac{15}{32}$	[illegible]	$\frac{17}{32}$	[illegible]
C	[illegible]	$\frac{5}{16}$	$\frac{11}{32}$	$\frac{3}{8}$	[illegible]	$\frac{7}{16}$	[illegible]	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$
D	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{11}{16}$	[illegible]	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{16}$	[illegible]
E	$\frac{35}{64}$	$\frac{39}{64}$	$\frac{21}{32}$	$\frac{23}{32}$	$\frac{25}{32}$	$\frac{27}{32}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{16}$	$1\frac{1}{8}$	1 [illegible]	$1\frac{1}{4}$	1 [illegible]	1 [illegible]

Machinery, N.Y.

Augusta, Ga. C. R. McGAHEY.
Supt. Lombard Iron Works.

A ROUND PLUG IN A HOLE OF THE SAME DIAMETER.

Editor MACHINERY:

"Perplexed," in MACHINERY for November, treats in an interesting way, the question as to whether or not oil takes up space; he also details experiments made with a view to determine whether a hole of a given diameter can be entered by a plug of corresponding diameter. The matter is one of specific interest, and that the subject is worthy of discussion is evident, from the editor's point of view, by the note in answer to the statement by "Perplexed." The questions involved are of a nature to awaken study and thoughtful difference of opinion in their elucidation.

Theoretically, it seems to me easily provable that for a plug to enter a hole it must be smaller than the hole. But to test the matter practically! There's the rub. If under the most painstaking and scientific treatment of a ring gage and plug it is determined that they are of similar size, and with or without lubrication fit together, why may not some iconoclastic mechanic suggest that there may be one or two molecules of divergence from exactness?

In Avery's Natural Philosophy, it is stated that "a molecule is so small that a total of 8,000,000,000 molecules of water is barely visible in the best of modern microscopes." An atom, again, is smaller than a molecule. The minute quantities of oil, whether atoms or masses that find their way into interstices between highly polished bearing surfaces, must be infinitesimal, but that there are such interstices which are filled by space-taking oil, is probable if not easily demonstrable.

Perhaps the independent opinion of an eager and experienced physicist, who had not read the article in MACHINERY, but who kindly dictated a note in answer to the questions raised by "Perplexed," may be read with pleasure and profit. This opinion, it may be added, was given by a man whose name would be instantly recognized by nearly all of your readers as an authority in his special field. He says:

"In reference to this matter, I would say that oil certainly does take up space. If there is no space for it, one of two things must happen: The surrounding material will be compressed or diminished in size to give the oil the room at the same time that the oil will be compressed and diminished in size, or the other thing that may happen is that the oil will squeeze out, for it will have to get out of the space if there is no room for it.

"As to the inquiry whether a plug can enter a hole of the same diameter, I should say that it certainly can. If pressed in, the hole will stretch a little, and the plug shrink a little by compression. In consequence of this, a plug of a little larger diameter can enter a hole smaller than itself, and it will depend upon the extensibility and compressibility of the materials of the plug and that which surrounds the hole how much one will give way to the other. There really need be-

no mystery about the matter, and I cannot see that it is a complex physical problem, depending upon the definition of the terms used. I would ask another question in this connection. Where will you find measuring apparatus so accurate that you can *measure* the plug and the diameter of the hole and say that they are absolutely of the same diameter? All measurement involves error, no matter how refined it is.

"Another question arises. Where will you find means so accurate that you can *make* the plug and the hole of exactly the same shape, say absolutely circular? You cannot do it. Moreover, the plug and the hole would have to be made of either the same material and kept at the same temperature absolutely, or the coefficients of expansion of the materials would have to be allowed for in the sizes of the holes and the plug at any given temperature."

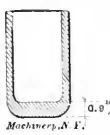
I trust the foregoing may add something to this discussion. It will be noted that the difficulties of construction and measurement are emphasized in the above expert comment.

Lynn, Mass. LYNN READER.

FINDING THE SIZE OF BLANK FOR A CUP.

Editor MACHINERY:

One of our customers wanted us to build a double hydraulic press for making cups, as shown in the sketch, the cups being the first operation for nickel-jacketed steel bullets. He sent us a sample piece from which latter one I had to find the dimensions for the blank which, of course, is a flat round disk. I found that the thickness of sheet metal from which the cup had been drawn was 0.9 millimeter at the bottom of the cup. The diameter I found as follows: I made use of the physical principle enunciated by Archimedes, which is that any body immersed in water weighs as much less as the weight of the water it displaces. Therefore, in the metric system, the volume of water displaced expressed in cubic centimeters times 1 is the weight of this volume in grammes. This fact makes the proceeding simple. First, I found the absolute weight of the cup in air, and second when suspended in water, by means of a chemist's scale. Weighed in air it was 2.923 grammes, and in water 2.55 grammes, the difference in weight being 0.373 grammes or cubic centimeters. From this data the diameter of the blank was figured by the following formula:



$$V = \frac{0.09\, d^2\, \pi}{4}, \text{ in which}$$

V = volume.
d = diameter of disk.
π = 3.14.

Transposing d^2, extracting square root and substituting 0.373 for V we have, successively,

$$d = \sqrt{\frac{4\,V}{0.09\,\pi}} = \sqrt{\frac{4 \times 0.373}{0.09 \times 3.14}} = 2.298 \text{ centimeters diameter}$$

of disk.

Berlin, Germany. OTTO ECKELT.

[The method of obtaining the diameter of the disk described by Mr. Eckelt is also interesting in that it shows the facility with which computations in volume and weight can be interchangeably effected in the metric system. The fact that the units of weight, capacity and extension are all based on the meter saves the laborious process necessary with our awkward English units.—EDITOR.]

SETTING CUTTERS ACCURATELY ON THE UNIVERSAL MILLING MACHINE.

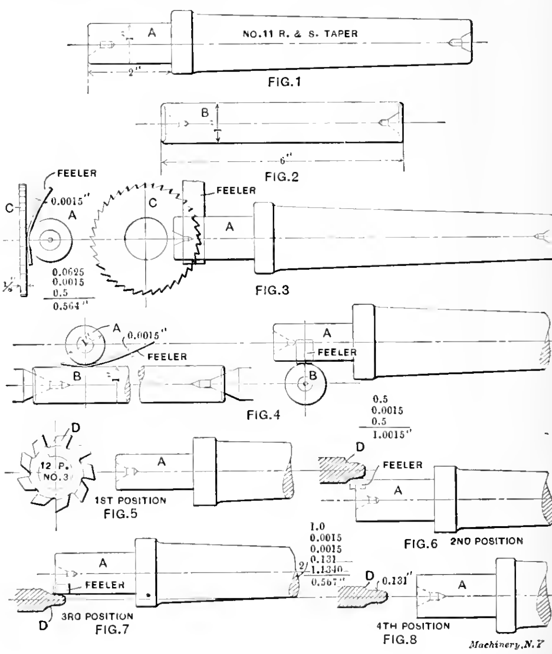
Editor MACHINERY:

To accurately set cutters on a milling machine by the following described method it is necessary that the several enumerated conditions be found in the machine and that the simple tools described be provided: 1. The platen or table screw, cross-slide or saddle screw and the knee or vertical screw each have a dial graduated to read in thousandths of an inch. 2. No lost motion between screws and nuts. 3. The platen or table set at right angles to the cone spindle. 4. The dividing head center and tailstock center in perfect alignment. 5. A steel plug center and straight arbor, hardened and ground, of the form illustrated in Figs. 1 and 2.

We will first consider the setting of an ordinary slitting saw. Place the saw on the cutter arbor in the cone spindle. Place the plug center, Fig. 1, in the dividing head spindle and move the dividing head so as to bring the plug center against the side of the saw as shown in Fig. 3. Adjust the plug center so that a standard feeler can be just drawn from between the saw and plug. Set the dial on the cross-slide screw to zero. Now, half the thickness of the saw plus the thickness of the feeler plus half the diameter of the plug center will be the distance to move the plug center by the cross slide screw to bring the saw exactly on the center. In this example it is 0.564 inch and of course can be directly measured by reading the cross-slide dial.

In order to set an end-mill or drill centrally it will be necessary to place the plug center in the cone spindle and to mount the standard arbor, Fig. 2, between the index centers, as shown in Fig. 4. Then raise the knee until the plug center and standard arbor are in the relative position illustrated in Fig. 4, with a standard feeler between them. Set the dial on the vertical or knee screw to zero. Having done this remove the plug center and the spindle arbor from the machine. Raise the knee by means of the vertical screw half the diameter of the plug center plus the thickness of the feeler plus half the diameter of the standard arbor and the machine will be set to use either the drill or end-mill. The distance the knee will have to be run up in this example is 1.0015 inch. It will be seen that by making the plug center and spindle arbor each one inch diameter it greatly facilitates the calculations.

In setting form gear cutters it is generally the custom to set the cutters centrally by having a center in the dividing head with a very sharp point and setting the point of the center to the line which is usually scribed on the top or back of the teeth of the cutter. But in the method to be described this line is not required and may be ignored. We will assume,



Setting Milling Machine Cutters.

however, that both sides of the tooth of the cutter are exactly the same shape and that the tooth is at right angles to the axis of the cutter. In short, that the cutter is symmetrical. Now place the gear cutter on the cutter arbor which is mounted in the cone spindle, being sure that the faces of the cutter and arbor bushings are free from dirt as otherwise the cutter will not run true. Place the plug center Fig. 1 in the dividing head spindle and put the gear cutter in the position as illustrated in Fig. 5 so that the centers of the cutter and plug center are approximately in the same horizontal line. In the second position shown in Fig. 6 place the plug center so that its end touches the side of the cutter tooth at about the pitch line.

Set the dial on the table screw and cross-slide screw to zero. Move the plug center away from the cutter in a longitudinal direction until there is sufficient room to pass in front of the cutter, and note the number of turns of the table screw that are required to accomplish this operation. In the third position, Fig. 7, the plug center is placed back in its original position longitudinally, but is moved over sideways so that it touches the cutter tooth on the opposite side at about the pitch line position. In making the cross slide move it will be necessary to note the number of thousandths on the cross-slide screw dial that are required. Now move the plug center away from the cutter in a longitudinal direction by means of the table screw so that the center plug will again pass in front of the cutter, and then change its lateral position by means of the cross-slide screw, one-half the number of thousandths that were required to move the plug center from the second position, Fig. 6, to the third position, Fig. 7. This will bring the cutter into the fourth position, Fig. 8, and it will be located accurately in the central position relative to the cutter.

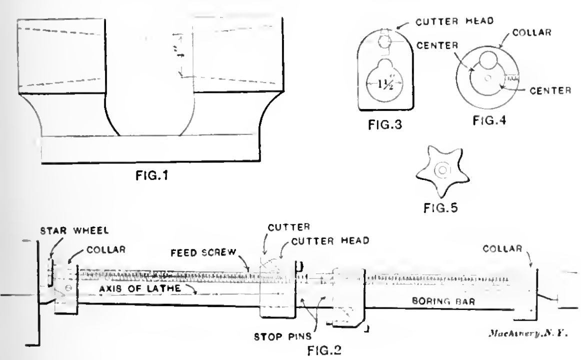
This method applies not only to form gear cutters but to concave, convex and double-angle cutters, provided the angle cutters are of same angle on each side of the center line. In setting a concave cutter by this method it will be necessary, of course, to use a plug center small enough to enter the groove and clear one side while touching the other side of the tooth. It is much easier to set this form of cutter because after having the machine set longitudinally it will be only necessary to move the plug center from one side to the other. The above methods may be used for a vertical milling attachment by utilizing the spindle of the attachment instead of the cone spindle. WILLIAM C. FORCE.

North Plainfield, N. J.

BORING BAR FOR BORING TAPER HOLES.

Editor MACHINERY:

In looking over a back number of MACHINERY I came across a description of a special boring bar for boring taper holes. It put me in mind of a bar that caught my attention during a visit which I made to a strange shop. It struck me as about the cleverest arrangement for boring taper holes that I ever had my attention called to. Thinking it might be interesting to some of your readers, I send a sketch of it along with this description.



Boring Bar for Taper Holes.

The bar in question was at work boring out taper holes, in what looked like the bearings of a grinder, Fig. 1. The head had a double bearing with the holes tapering outward. The work was held in a fixture fastened to the carriage of the lathe, and one setting was sufficient for any number of pieces. The bar was about 1½ inch diameter by 24 inches long and was ground to size. With a ¾-inch forming mill, a round groove ½ inch deep was cut in one side of boring bar, to allow for the feed screw, Fig. 2. This feed screw was cut with a right-hand thread on one end and a left-hand thread on the other. Small cutter heads were bored out to fit the bar, and tapped out, one right and the other left, to engage the feed screw, similar to a half nut. I presume these heads were tapped out before the 1½-inch bearing hole was bored. The heads were a sliding fit on the bar and controlled by the feed screw. Fig. 3 is an end view of head showing its general appearance. The taper was obtained by having the centers of the bar drilled off the true centers at opposite points, thus apparently imparting a wobbling movement to the bar. Thus the center of bar would practically run true, where the heads were started from, gradually increasing the throw until at the extreme ends. The feed screw was held in place by cast-iron collars on either end, as per Fig. 1, and was driven by the star wheel, Fig. 5. The cutter was a piece of square high-speed steel held in place by a setscrew. Stop pins in the bar insured the heads starting from the same point each time. Fig. 4 shows how the centers were drilled to give the necessary throw. TEXAS.

ANGLES OF SCREW THREADS.

Editor MACHINERY:

The following table was compiled to simplify and shorten the process of finding the angles made by screw threads. There is but one operation, that of division, and a table of tangents is unnecessary. While the results obtained by the short method first given are not strictly accurate, they are practically so, for the greatest error is less than one minute for all ordinary diameters and pitches.

The first column of the table contains the number of threads per inch, from one to twenty-four. The second column gives the angles in degrees and fractions of a degree, made by helices of 1 inch to 1-24 inch pitch and 1 inch diameter. To find the angle made by a helix of a given diameter and pitch, find in the first column the given pitch and take the angle opposite this in the second column. The angle taken, divided by the given diameter of helix, equals the angle sought.

For example, if the angle to be found is the average of those made by the top and bottom of a square thread 1⅛ inch diameter and four threads per inch, that is to say, of a helix 1⅛ inch diameter then $4.55 \div 1.125 = 4.04$ degrees $= 4$ degrees 2.4 minutes. The angles made by the top or bottom of the same thread can be found, if required, by dividing the same constant by the respective diameters. If the exact angle is required, the constant in the third column and opposite the given pitch, is divided by the diameter of the given helix. The quotient is the tangent of the required angle, which must be found in a table of natural tangents.

To illustrate, by using the diameter and pitch mentioned in short method, $0.07958 \div 1.125 = 0.07074 \doteq$ tan 4 degrees 2.7 minutes.

Threads per inch.	Angle for 1 inch diameter.	Constant $= \frac{\text{Pitch}}{3.1416}$
1	17.66	.31831
2	9.04	.15916
3	6.06	.10610
4	4.55	.07958
5	3.61	.06366
6	3.04	.05305
7	2.60	.04547
8	2.28	.03979
9	2.03	.03537
10	1.82	.03183
11	1.64	.02894
12	1.52°	.02653
13	1.40	.02449
14	1.30	.02274
15	1.22	.02122
16	1.14	.01989
17	1.07	.01872
18	1.01	.01768
19	.96	.01675
20	.91	.01591
21	.87	.01516
22	.82	.01431
23	.79	.01384
24	76	.01326

Meriden, Conn. T. E. WELSH.

* * *

The following three recipes for fastening wood to tin plate should also be useful for joining other materials of dissimilar characteristics that are required to be cemented together: 1. Dissolve 1 part pure India rubber, cut fine, in 5 or 6 parts of benzine or carbon disulphide. 2. Soak 1 ounce of glue in water for 12 hours, remove, melt down and add 1 ounce brown sugar, 1 ounce gum arabic, and 4 ounces of water; apply hot. 3. Dissolve 1 part of shellac in 3 parts of strong ammonia.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO PREVENT TOOLS RUSTING.

A lump of unslaked lime, placed in a box with bright tools, will prevent rust, as it absorbs moisture. The lime should be renewed occasionally. C. P. L.

TO POLISH WOOD HANDLES.

Rub with a piece of waste dipped first in linseed oil, then in shellac. After rubbing, allow it to stand, then rub again, dipping alternately into the oil and the shellac. This gives a very high polish, which will not scratch nor flake off.

St. Johnsbury, Vt. W. H. SARGENT.

TO CLEAN STAINED BOTTLES

A good way to get the stains out of bottles is to fill them half full of water and then put in a handful or two of cast iron borings, coarse ones preferred; shake well. It will clean any bottle no matter how badly it is stained. The boys in our shop use it for cleaning their tea bottles and it works all right.

Toronto, Ont. GEO. WILLIAMSON.

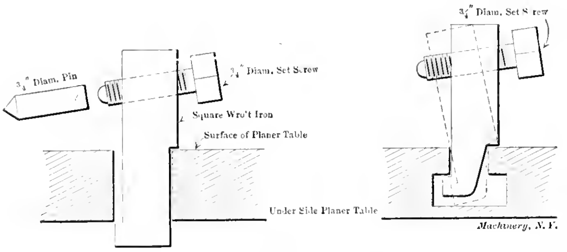
TO PRESERVE SCREWS, ETC.

Some toolmakers—and others—like to save their small old screws, nuts, etc., the common practice being to keep them in small tin boxes where they soon become rusty and unfit for use. A good way to keep such scrap or new screws of various sizes, is to keep them in small large-neck bottles, each provided with a cork and labeled if desired. In this way one can always see instantly just what they have and how many of each and the pieces never get rusty. CARROLL ASHLEY.

Rochester, N. Y.

CHUCKING PIECES FOR PLANER WORK.

The illustration represents chucking pieces for planer work, which for folding flat work like locomotive frames, frame tongues, etc., on a planer table beat anything I have ever used. I make them out of 1¾-inch square iron, cut off to proper length; a number of them are chucked and planed



out as shown. The pins or fingers are ¾-inch soft steel, case-hardened, and I have an assortment from ½-inch to 8 inches in length. The long chucking pieces I use in square holes in the table, the short ones in the grooves. In using I drive punch marks into the work for the point of the finger to set in. A. F. BIERBACH.

Milwaukee, Wis.

HINTS ON HARDENING.

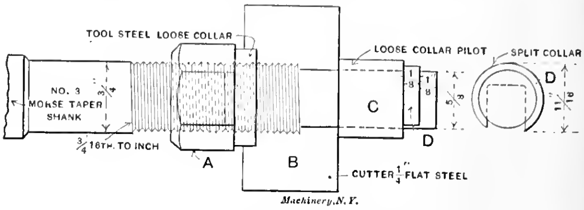
Only those who have had some experience in hardening a variety of small tools will understand or appreciate thoroughly what is about to be said.

I have experienced, in hardening, that some water does not take kindly to the hot pieces of steel, but rather stays away from it, as it would from a stick coated with tallow. The result is the tool is not hard. To overcome this, add about one-third muriatic acid to the water and the result will be surprisingly improved.

Here is something that toolmakers are meeting with every day, *viz.*, small and delicate-shaped tools are to be hardened, and it is a question in the mind of the workman whether to use water or oil to harden in. Water may crack the tool and in oil it may not harden, but suppose he tries oil and it does not harden the first time; the second time of heating and dipping will most surely crack it and the work is spoiled. For such work I have used a mixture of one-half water and one-half glycerine with best results; this mixture never fails to harden and I have never had a piece spring out of shape or crack when dipped in it. L. S. B.

BORING OR FACING BAR.

The sketch shows a boring or pin facing bar, which will be found very convenient for facing for heads of bolts or nuts; also for counterboring. This size is made to take ¼ inch flat tool steel of any width up to 1¼ inch. By slipping off the split collar, any size pilot collar can be put on. The pilot



collar must be of such length that the cutter will rest on it instead of bearing on the bottom of the slot in the bar. This is necessary, of course, to keep the split collar in place. I would advise making all parts of this bar, except the nut, of tool steel.

Marquette, Mich. CHAS. V. KINSMAN.

BLUING FOR LAYING OUT WORK.

When a small amount of marking or laying out of work is to be done, on steel, brass, iron, or copper, apply with the finger a thin coat of Prussian blue, such as is sold in thin metal tubes, at artists' supply, and paint stores. This does away with the objectionable feature of repolishing the work after it is completed, as it can be easily rubbed off, after the work is finished. It is far ahead of red lead for surface scraping work, and fits for punches, dies, etc., as it is more plainly seen. FRANK G. STERLING.

Lowell, Mass.

TO TEMPER A TWIST DRILL TO DRILL HARDENED STEEL.

Holes may be drilled in tempered steel, such as circular saws, springs, music wire, etc., by hardening an ordinary twist drill in sulphuric acid. The pure acid should be placed in a saucer or other flat-bottomed vessel to a depth of about ⅛ inch. The point of the drill is heated and dipped in the acid to that depth, making the point extremely hard, while the remainder remains soft. If the point should break, reharden as before, but have a little less acid in the vessel. In this manner the drill may be hardened just enough to drill the steel, but not brittle enough to break when coming through.

New York. H. J. BACHMANN.

TO REPAIR FROST-CRACKED WATER-JACKETS.

Among the ways of repairing frost-cracked water-jackets of gasoline engines might be noted this: A patch was made of stiff band iron, long enough to cover the crack, and 2½ inches wide; then there was cut out of some heavy asbestos mill board two thicknesses of the same size, the whole center of which was removed, leaving only a rim about ½ inch wide. This rim of packing was then laid over the crack and packed full of a mixture of equal parts of fine cast-iron borings and finely powered quicklime; then the iron patch was clamped tightly over it and the jacket filled with water. The expansion of the lime, when wet, forced the mixture into the crack, which soon rusted tight enough so that the patch was removed, the surplus lime scraped off, and the job finished up with a coat of paint. W. D. GRAVES.

Brown's Valley, Minn.

* * *

An error obvious to any one who ever uses logarithms occurred in the October data sheet, the logarithm of 1 being given as zero. The same also applies to the square, cube, square root, and cube root of 1.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

135. COMPOUND FOR CLEANING BRASS.

To make a brass cleaning compound use oxalic acid, 1 ounce; rotten stone, 6 ounces; enough whale oil and spirits of turpentine of equal parts, to mix, and make a paste.

Dayton, Ohio. G. E. HETZLER.

136. CEMENT FOR IRON AND MARBLE.

For fastening iron to marble or stone a good cement is made as follows: 30 parts plaster paris, 10 parts iron filings, ½ part sal ammoniac mixed with vinegar to a fluid paste fresh for use. R. M.

137. ANTI-FREEZING SOLUTION.

A solution for water jackets on gas engines that will not freeze at any temperature above 20 degrees below zero may be made by combining 100 parts of water by weight with 75 parts of carbonate potash and 50 parts of glycerine. This solution is non-corrosive and will remain perfectly liquid at all temperatures above its congealing point. J. C.

138. CEMENT FOR LEATHER AND IRON.

To face a cast iron pulley with leather apply acetic acid to the face of the pulley with a brush which will roughen it by rusting, and then when dry apply a cement made of 1 pound of fish glue and ½ pound of common glue, melted in a mixture of alcohol and water. The leather should then be placed on the pulley and dried under pressure. R. M.

139. WHITE WRITING FLUID FOR BLUE-PRINTS.

A fluid which I find is as good as any I have ever used for writing white on blue-prints is made of equal parts of sal-soda and water. Another fluid, not as good, is made by mixing equal parts of borax and water. Both these fluids must be used with a fine-pointed pen; a pen with a blunt point will not work well. C. W. MORRISON.

Allegheny, Pa.

140. WATERPROOF PAINT FOR PLASTER.

To make waterproof paint for plaster get some mica plates, bleach them by fire, boil in hydrochloric acid, wash and dry and reduce to a fine powder; then mix with sufficient quantity of collodion to make it run from the brush. Apply with ordinary paint brush. F. L. ENGEL.

New Britain, Conn.

141. RE-INKING TIME-CLOCK RIBBONS.

For re-inking time-clock ribbons we use the following receipt for black: 1 ounce aniline black; 15 ounces pure grain alcohol; 15 ounces concentrated glycerine. Dissolve the aniline black in the alcohol and then add the glycerine. For blue use prussian blue, and for red use red lead instead of the aniline black. This ink is also good for rubber stamp pads.

Moline, Ill. ALBERT D. KNAUEL.

142. TO SCALE CAST IRON.

To remove the scale from cast iron use a solution of 1 part vitriol and 2 parts water; after mixing, apply to the scale with a cloth rolled in the form of a brush, using enough to wet the surface well. After 8 or 10 hours wash off with water, when the hard scaly surface will be completely removed.

Schenectady, N. Y. R. B. CASEY.

143. TO FASTEN RUBBER TO WOOD.

Make a cement by macerating virgin gum rubber, or as pure rubber as can be had, cut in small pieces, in just enough naphtha or gasoline to cover it. Let it stand in a very tightly corked or sealed jar for fourteen days, or a sufficient time to become dissolved, shaking the mixture daily.

Another cement is made by dissolving pulverized gum shellac, 1 ounce, in 9½ ounces of strong ammonia. This of course must be kept tightly corked. It will not be as elastic as the first preparation. OSCAR E. PERRIGO.

Neponset, Mass.

144. MARKING POLISHED STEEL.

A very handy way of marking polished steel for sizes, instructions, etc., is to keep a small oil can filled with turpentine with which to saturate a small piece of waste as needed; rub over the surface to be marked and then do the marking with an indelible copying pencil, which will show up very plain. Of course the can of turpentine also comes in handy to use for drilling hard steel, springs, etc.

St. Paul, Minn. ARTHUR MUNCH.

145. TO BLACKEN ZINC FOR LAYING OUT.

This receipt of course is the same as that often used for coating iron or steel but it is not generally known among many of the craft that it may be used to prepare zinc for sketching, giving the zinc a dark coating. Dissolve 1 ounce sulphate of copper in 4 ounces water, add ½ teaspoonful of nitric acid and apply a thin coating to the zinc with a piece of waste. If used for iron or steel the work should then be rubbed dry. Care should be taken in handling and using the mixture, as it rusts iron and steel badly if left on. R. M.

146. TO CLEAN RUSTED STEEL—TO PRESERVE STEEL FROM RUST.

Rusted steel can be cleaned by brushing with a paste compound of ½ ounce of cyanide potassium, ½ ounce castile soap, 1 ounce whiting, and water sufficient to form a paste. The steel should be washed with a solution of ½ ounce cyanide potassium in 2 ounces water.

To preserve steel from rust dissolve 1 part caoutchouc and 16 parts turpentine with a gentle heat, then add 8 parts boiled oil, and mix by bringing them to the heat of boiling water. Apply to the steel with a brush, the same as varnish. It can be removed again with a cloth soaked in turpentine.

New Haven, Conn. A. L. MONRAD.

147. ALLOYS FOR DRAWING COLORS ON STEEL.

Alloys of various composition are successfully used for drawing colors on steel. To draw to a straw color use 2 parts of lead and 1 part of tin, and melt in an iron ladle. Hold the steel piece to be drawn in the alloy as it melts and it will turn to straw color. This mixture melts at a temperature of about 437 degrees F. For darker yellow, use 9 parts of lead to 4 parts of tin, which melts at 458 degrees F. For purple, use 3 parts of lead to 1 part of tin, the melting temperature being 482 degrees F. For violet, use 9 parts of lead to 2 parts of tin which melts at 594 degrees F. Lead without any alloy will draw steel to a dark blue. The above apply to steel only since iron requires a somewhat greater heat and is more or less uncertain in handling. MAX DEHNE.

Cleveland, Ohio.

148. FOR CHAPPED HANDS—EYE WASH.

I noticed a receipt for a cure for chapped hands, in the December MACHINERY. This may be good but as glycerine is bad for the skin of many people, when used for such purposes I herewith give you a receipt which I believe will be found more generally satisfactory, as it contains less glycerine. I worked in a drug store for several years and tried many combinations for chapped hands and finally selected the following: Bay rum, 3 ounces; glycerine, 1 ounce; carbolic acid, ½ drachm (30 drops). Wash the hands well and apply while hands are soft, preferably just before going to bed. *Rub in thoroughly.* This rarely fails to cure the worst "chaps" in two nights.

Also a most excellent eye wash is as follows: boric acid, 40 grains; camphor water and distilled water, each 2 ounces. Bathe the eyes freely several times a day. This is handy to have when the eyes are inflamed from having steel or emery, etc., in them. GEORGE C. NASH.

Rockford, Ill.

* * *

One of the big steel manufacturers at Sheffield, Eng., is said to be exhibiting a knife with 75 blades, some scene about Sheffield engraved on each blade. The firm has a standing offer of $75 to any one who can shut all the blades of this highly useful tool without cutting his fingers.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

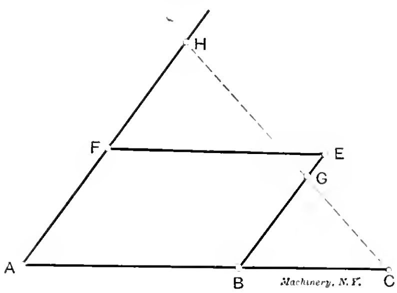
Give all details and name and address. The latter are for our own convenience and will not be published.

9.—Steel. Are the arms of a flywheel or gear any less likely to break from the shrinkage of the casting if it is made with five or seven arms or spokes, instead of six?

A. Other conditions being the same there should be no difference, because the stresses caused by shrinkage are radial and are resisted by the rim, being normal to it in either case. For this reason an odd number of spokes could be no more flexible in adjusting to the shrinkage than an even number, as with either an odd or even number the hub must remain in the center.

10.—L. B. O.—Can you give us any information in regard to the pantograph and its application to machinery?

A.—The pantograph consists of 4 links forming a parallelogram having opposite sides equal. One side, *A B*, is extended to some convenient point as *C*, which is the pivot point. The adjacent side, *A F*, is also extended and serves as a handle by which the pantograph can be moved into any desired position about its pivot, *C*. Pencils at points *H* and *G* respectively will trace similar figures, which, however, will be unequal in size. These points are located upon a straight line extending



from *C* to *H*, as shown dotted in the figure. The principle of the pantograph depends upon the fact that triangles *C B G* and *C A H* are similar triangles and that they will remain similar whatever the position of the pantograph may be. This being the case the distances of points *H* and *G* from pivot *C* will always be in the same ratio and the figures traced will necessarily be the same. The pantograph is the familiar device used by draftsmen for reproducing illustrations on a different scale from the original and is also employed in routing and engraving machines, for indicator reducing motions, etc.

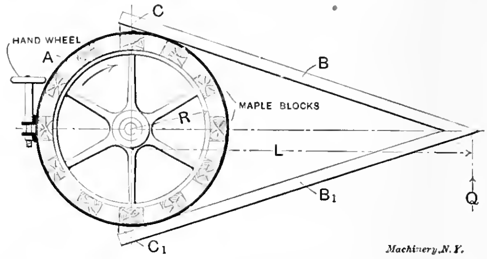
11. J. H. K.—I wish to make some small aluminum castings. They are not very regular in shape, being thinner in some parts than others. I have been making them but they don't turn out just as satisfactory as they should. I use a metal mold, but while the mold is quite smooth the castings come out pitted which is not very desirable as they must be highly finished. On this occasion I am limited to weight, therefore I cannot alloy the aluminum as it will make the castings too heavy. Please state which is the best kind of metal for the molds, also the best furnace. Must I use a crucible to get best results? In fact I would like to have the information on the best practice.

Answered by Dr. Richard Moldenke.

As your correspondent cannot alloy his aluminum, his attention should be directed as much as possible to keep the metal from burning influences. Hence he should use the crucible altogether, as in this way he keeps his metal from contact with fuel or gases. Aluminum castings should be poured as cold as they will run properly to get the best results, but as in this case the work is light and therefore has to be run quite hot, it would be good to heat up the metal molds, if this can be done conveniently. As a general proposition, a metal mold should be as nearly the same in composition as the metal to be cast into it, the necessary precaution being taken to alloy with enough of other metals to get the melting point of the mold higher. In this case an alloy of aluminum with some copper would do all right. Cast iron can be used very well, however, without difficulty, as the castings are small and the contraction will be a small matter to deal with. Hence the use of the crucible well protected by charcoal on the metal, the heating up of the molds, and the pouring of the metal as cold as it will run well, should help your correspondent to better results.

12. E. H. N.—Give a formula for finding the pressure to be applied to a brake band to hold a known load at a radius of 5 feet 3 inches (63.02 inches exactly) as in the case of the Prony brake. The brake wheel is 20 inches outside diameter and 6 inches face. The band is lined with maple wood shoes, slash grain, and we intend to cool the brake wheel with water on the inside and to use tallow for lubricating the blocks. The shoes are riveted to a band which is drawn together on the wheel by means of a hand wheel and screw.

A. A formula for giving the necessary tension in the band of a Prony brake is given in Jones' Machine Design, Part II. It is only to be used, however, when the arms, BB_1, are attached to the brake band, *A*, at *C* and C_1, diametrically oppo-



site, or 180 degrees apart. It is only when attached at these points that a practical working formula, it is asserted, can be employed, for the elasticity of the materials makes the result uncertain for other positions of attachment of the arms. The formula is as follows:

$$T = \frac{Q\,L\,10^{.00758\,\mu\,180}}{2\,R\,10^{.00758\,\mu\,180}}$$

In simple form, but applicable only with the points of attachment 180 degrees apart, it is:

$$T = \frac{Q\,L\,10^{1.3664\,\mu}}{2\,R\,10^{1.3664\,\mu} - 1},$$

in which

T = greatest tension in brake band.
Q = force applied at end of brake to resist its rotation.
L = distance from center of drum to line of action of Q.
R = radius of brake drum.
μ = coefficient of friction.
π = 3.1416.

For example, if the load at the end of a lever arm 5 feet 3 inches or 63 inches were 150 pounds; the coefficient of friction 150 pounds; and the coefficient of friction 0.1, which would apply for the conditions given, the tension would be

$$T = \frac{150 \times 63 \times 10^{.13664}}{2 \times 14 \times 10^{.13664} - 1} = 1.252 \text{ pounds.}$$

If it is assumed that the coefficient of friction is, in general, 0.1, the formula may be expressed in the simpler form,

$$T = \frac{1.165\,Q\,L}{2\,\pi\,R\,\mu},$$

in which the literal quantities have the same values as above.

* * *

Apropos of the receipts for blackening sheet tin or zinc for template work, which have been given recently, it may be profitably mentioned that zinc can be blackened by the use of chloride of antimony dissolved in muriatic acid. Just sufficient muriatic acid is added to the chloride of antimony to dissolve it, and the solution obtained is diluted with 20 parts of grain alcohol. It is applied to the zinc with a brush or by dipping. Care should be taken that the solution is not too strong in acid, as it will not work properly and the coating will not adhere.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

LATHE ATTACHMENT FOR BORING.

This tool has been designed to facilitate the operation of boring in the lathe and will take the place of a boring mill in a satisfactory way within its range. As shown in Figs. 1 and 2, it consists of a housing or bracket carrying a vertical slide, bolted to the rear of the carriage, and a knee adapted to slide thereon for carrying the work. The raising or lowering of this knee is done by the crank and screw on the rear standard. After adjusting the knee to suit the height of the work being done, it may be clamped in place at the front end by the bolts which slide in the solid brackets shown in Fig. 2. Not only is the clamping surface of the knee planed true with

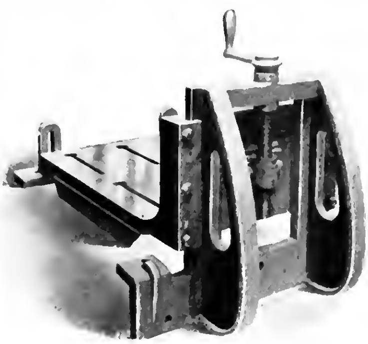


Fig. 1. Lathe Attachment for Boring.

the spindle, but the upright surface at the rear is also squared to allow its use as a gage surface in setting the work parallel to the axis of the lathe.

This device obviously does away with the necessity for blocking up the work, which occurs when trying to use a boring bar in the lathe without special holding arrangements. To get the full capacity of the machine, the makers, H. B.

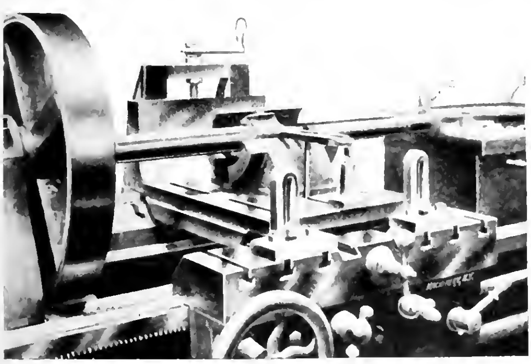


Fig. 2. Boring Attachment in use.

Underwood & Co., 1025 Hamilton St., Philadelphia, Pa., advise that, instead of mounting the boring bar on the centers, it be held in a bearing clamped to the faceplate and revolving at the rear end in a center rest. This will allow much heavier cuts to be taken than will be possible when the bar is mounted on centers in the usual way.

PRATT & WHITNEY TURRET LATHE AS ADAPTED TO FINISHING CASTINGS.

The two accompanying half-tones show the well-known Pratt & Whitney turret lathe adapted to the finishing of gasoline engine cylinders. The nearer view, Fig. 2, shows a casting in place in the special chuck used on this job. As may be seen, the operation consists of finishing the bore and turning the collar and the flange at the lower end of the cylinder. The construction of the chuck is such that each cylinder is held at eight points. Two clamps are used, each of which has two points of contact with the work, and these in combination with the four opposed fixed contacts, are sufficient to clamp the work firmly without springing it as would be the case if a lesser number of gripping points were used.

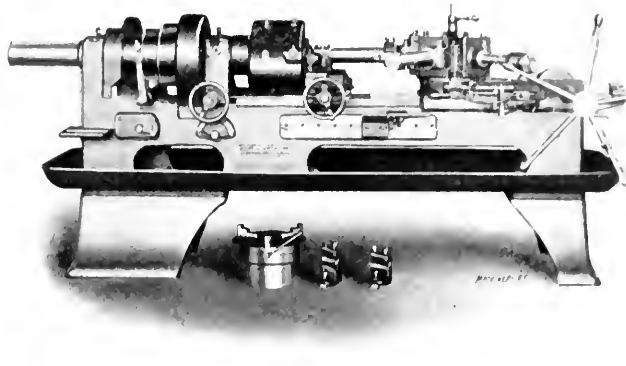


Fig. 1. Turret Lathe Rigged for Boring Gas Engine Cylinders

The turret carries a series of boring tools and reamers. One of the boring tools carries on its shank a tool holder for finishing the collar at the base of the casting, as may be seen in Fig. 1. The finishing reamer is of the inserted tooth expansible type, and is held in a floating holder. Cross slide tools are provided for finishing the flange, these tools being independent of the turret in all their functions, so that the two slides may be used together.

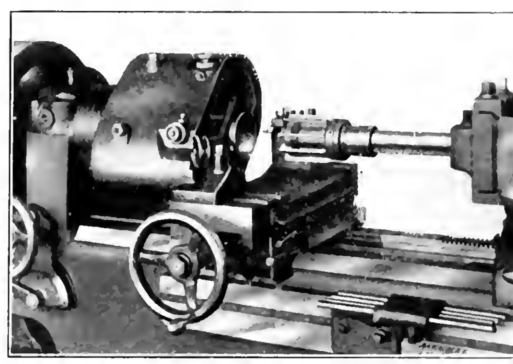


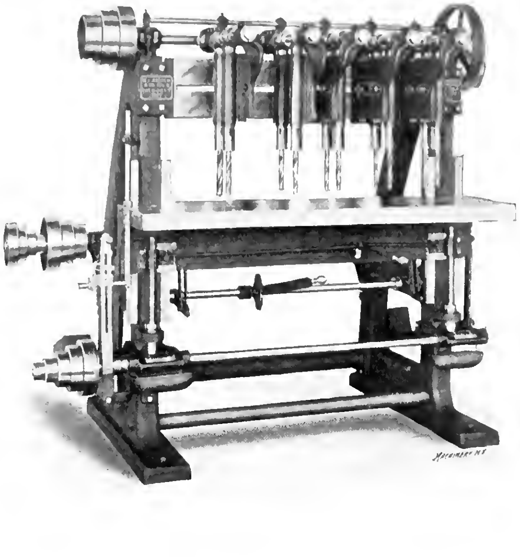
Fig. 2. Cnuck and Tools for Gas Engine Cylinders.

There are numerous applications for this particular machine in automobile work. Where manufacturers have insufficient work to keep the machine constantly at work on castings, it is advisable to have it equipped with the rod feed and collet mechanism, thus permitting rod work also to be handled. Quotations and detail specifications covering work of this kind will be furnished upon application to the makers, the Pratt & Whitney Co., Hartford, Conn.

MULTIPLE DRILLING MACHINE.

The machine shown in the accompanying half tone differs from the usual construction of machines of this type in being provided with two spindles on each head. Both of them are adjustable at right angles to the face of the cross rail. They are driven from a horizontal shaft through a series of bevel gears. The feed is applied to the table, which is raised by screws at each end; an adjustable automatic stop throwing out the feed at any desired point. The horizontal lever seen under the platen is then operated to open the half nuts through which the table is fed, and the platen may be lowered by the lever attached to the rockshaft underneath the machine. The table is counterbalanced by adjustable weights.

All the spindles, which are made to take Morse taper shanks, are adjustable, and can be set as close as 3 inches center to center or up to 12 inches apart center to center, lengthwise of the rail; and they may also be staggered across the table from 0 to 7 inches. There are four changes of feed and the machine has sufficient power to drive 10 drills of from 1/8 to 3/4 inch

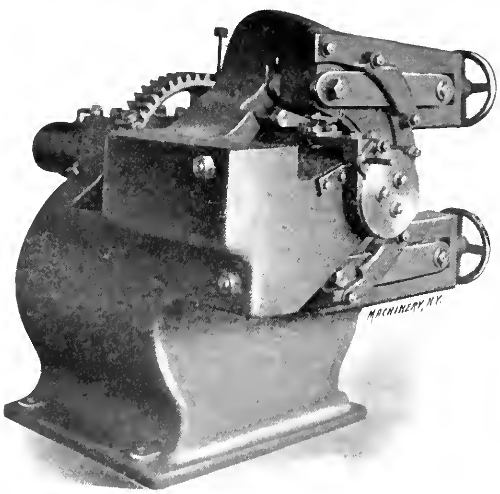


Andrew Multiple Spindle Drill.

diameter in steel or iron. Other sizes are made which will drill as close as one inch center to center, and up to 12 feet between centers of outside spindles. M. L. Andrews & Co., Cincinnati, Ohio, are the builders of this machine.

ROTARY THREAD ROLLING MACHINE.

The Acme Machinery Co., Cleveland, Ohio, have recently designed the rotary thread rolling machine shown in the halftone below. In this machine the threading dies, instead of being of the reciprocating type, are composed of one rotary or revolving die which runs continuously in one direction,

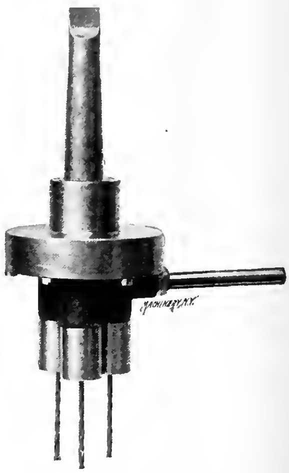


Rotary Thread-rolling Machine.

and one segmental die which remains stationary after it is adjusted to the job. The bolt or piece that is to have the thread rolled on it is placed between the two threading dies and carried around with the rotating die, which is mounted on the main shaft or spindle. The segmental die is carried in a heavy block which is eccentric to the shaft and by loosening one of the hand wheels and tightening the other it is advanced or withdrawn to vary the distance between it and the rotary member. The feeding is done by an oscillating carriage, seen plainly at the front end of the spindle. This carriage is operated by dropping a pawl into connection with a notched disk which moves the carriage with the work forward into the radius of action of the dies. The jaws which carry the work then open automatically and allow the carriage to drop back by its weight to the feeding position again. These machines are made in two sizes. The one-inch machine is furnished with countershaft, wrenches, and five pairs of dies, weighs 10,000 pounds and occupies a floor space of 4 feet 10 inches by 6 feet 6 inches. The two-inch machine is similarly equipped, weighs 20,000 pounds and occupies a floor space of about 7 feet by 9 feet.

MULTIPLE DRILLING ATTACHMENT.

The drilling attachment shown in the accompanying halftone is designed for finishing a number of holes at one time without making any change in the drill press used and without reversing the rotation of the spindle. The drills, of which three are used in the case illustrated, are driven by straight spur gears throughout in the larger sizes and by an internal gear in the smaller sizes. These gears are wholly or partially encased according to the size of the device and the conditions of the work. The attachment is so designed as to make the bearings as large and as long, and give the gears as coarse a pitch as is practicable. The device is applicable to any case where two or more holes are to be drilled in constant relation to each other, such as drilling cylinder heads for small engines and pumps, or for any special work where quantity is to be considered. The spindles are not adjustable, but the normal cost is low enough so that one or more

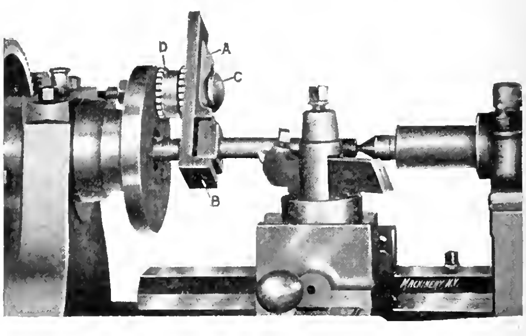


Multiple Drilling Attachment.

can be installed to suit different dimensions. The makers, The Francis Reed Co., of 43 Hammond St., Worcester, Mass., furnish it complete, to order only, according to specifications fitting it to the class of work it is designed for.

ARMSTRONG BOLT DRIVER.

The device shown in Fig. 1 has been devised and is being put on the market by Armstrong Bros. Tool Co., Chicago, Ill. The cut shows quite plainly the way in which the device is used. It consists essentially of two jaws, *A* and *B*, which are provided with minute serrations on the two surfaces which come in contact. These jaws are held together and clamped to the faceplate of the lathe by a bolt, *C*. The washer, *D*, holds the device far enough away from the face plate to allow the point of the live center to project through the lower jaw into the center hole of the bolt which is being turned. Both

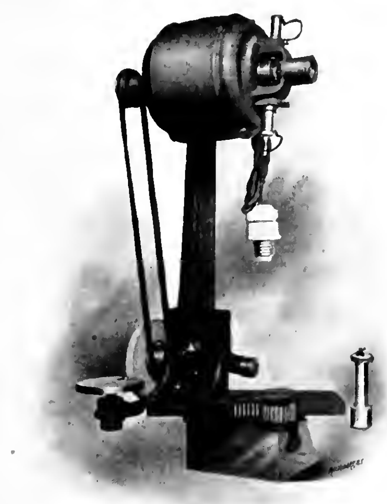


Armstrong Bolt Driver.

of the jaws are slotted so they may be adjusted to fit any size of bolt within their range and be used on any diameter of faceplate as well. The device is made in three sizes having capacities for 2-inch, 3-inch and 4-inch stock, respectively. It is not, of course, limited in its application to the turning of square and hex-headed bolts, but may be used as well for square or rectangular bar stock, or for irregular forgings which present suitable driving surfaces. The washer, *D*, is extensible to permit the use of the tool with centers of varying lengths. The parts are drop forged throughout.

THE MUELLER GRINDING ATTACHMENT.

The device shown herewith is intended to be used in lathe tool posts (or in connection with other machines) for truing up the centers, for grinding work held between the centers, or for facing and doing internal work in the chuck or on the faceplate. Power is furnished to the motor from the ordinary incandescent lamp socket. From the motor the wheel is driven by a round belt. The wheel spindle, the bearings of which are adjustable to take up wear, can be located at the proper height to bring it in line with the center line of the lathe. For truing up centers the rack and pinion shown give a movement to the wheel at an angle of 30 degrees with the line of the spindle, thus grinding all centers to an exact 60-



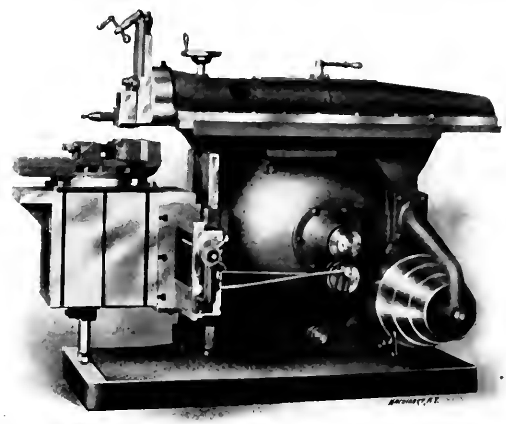
The Mueller Grinding Attachment.

degree angle without the use of a compound rest. For internal grinding the extension arbor shown at the right is used in place of the large wheel. The arrangement may be used independently of the lathe for sharpening cutters, saws, etc., and a rest for this purpose is provided. Provision is made for taking up the slack of the endless belt and for keeping the dust and emery away from the bearings of the spindle. This device is made by the Mueller Machine Tool Co., Cincinnati, Ohio.

THE CINCINNATI RAILROAD AND MANUFACTURING SHAPER.

The Cincinnati Shaper Co., Cincinnati, Ohio, are making the shaper shown in the accompanying half-tone. The gearing and drive of this machine have been proportioned with the intention of making it the most powerful shaper of its stroke on the market, and of course the frame, slides, etc., have been strengthened to correspond. The column, ram, and rail, are all unusually heavy and made of suitable form to withstand the strains to which they are subjected. The main gear journal has two diameters, the inner end being twice that of the outer end, thus overcoming any tendency to break at the junction of the gear. There is also a third or outer bearing to the cone shaft. The crank block is a steel casting and is set well into the cup of the gear, thus permitting the rocker arm to travel close to the edge of the rim, avoiding the usual overhang. Ram, head, rail, apron and crank wheel slides are fitted with full length taper gibs throughout, adjustable endwise by single screws, this being preferable to gibs with setscrews impinging with various pressures at the several points in the length of the gib. An outer support for the table is furnished with each machine without extra charge. The vise has a graduated swiveling base with jaw plates of annealed tool steel, and is set up by a double screw arrangement. Shafts are of high-carbon steel, gears are cut from the solid, flat sliding surfaces, are all hand scraped, and all pinions are of cast steel.

Changes and adjustments for the length of the stroke, the position of the ram, the height of the table, etc., may be made while the machine is in motion. A number of extra attach-



Cincinnati Heavy-duty Shaper.

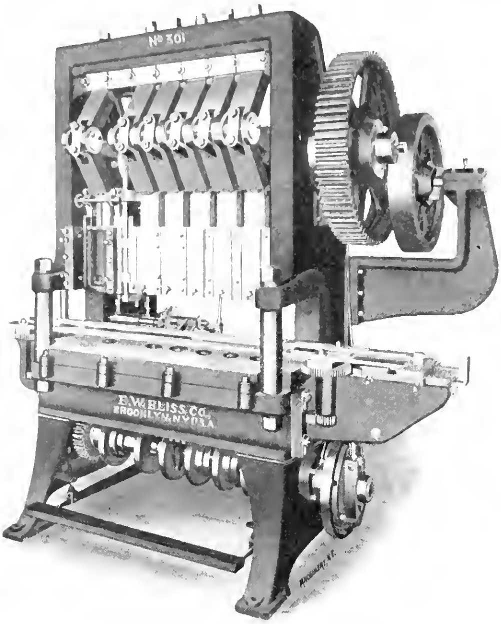
ments may be furnished when desired, such as power down feet, revolving table, tilting table, concave attachment, motor and gear-box drives; the machine may also be had in either the single or back-geared form, the ratio of gearing being in the one case 7.2 revolutions of the shaft to one stroke of the ram, and in the other 30 to 1. The machine shown has a 33-inch stroke with 15-inch vertical travel of table and 32 inches horizontal travel. The top of the table has a surface of 16 inches wide by 30 inches long. It will take a tool with a 1 x 2¼ inches shank and will key seat a 4-inch shaft. The net weight of the machine is about 6,300 pounds.

BLISS AUTOMATIC MULTIPLE SLIDE PRESS.

The press illustrated in the cut is of recent design, and is intended to work continuously on products such as lamp parts, etc. It has a double action cutting and drawing slide with a lift-out, also five single action cutting and forming slides, each having an independent lift-out. The press is fitted with an automatic roll feed which takes the stock from the reel; also a grip and carrying feed which carries the first operation cup or shell from one to another of the five single action slides. The number of single action slides may be lessened or increased as the nature of the work demands.

Each slide has its own adjustment, shown at the top of the press, as well as its own gibbing device. This makes the press particularly adapted for the manufacture of such articles as lamp burner parts and similar pieces which are cut and formed, pierced, trimmed, stamped and finished in several successive operations, since a light operation with delicate dies is thus not thrown out of alignment by a heavy adjoining operation. The press is run at from 35 to 50 strokes per minute, and with six slides as shown, it will produce from 210 to 300 operations per minute, without requiring any intermediate handling. Provision is made for rapidly adjusting the feed and working parts from one size to another. The number of operations that may be performed by this process is limited only to the number that may be done without annealing. Where annealing is essential it is sometimes advantageous to draw the first operation in a plain press, after which the cup or shell is annealed. The roll feed on the automatic press is done away with in this instance and a dial feed substituted, on which the first operation shell is placed and

from which it is carried by the lateral feeding device the same as when it is used in connection with the roll feed. The rolls on the press illustrated will feed up to 5 inches long and up to 5 inches wide, making the largest permissible diameter of trimmed edge on the die approximately 5 inches. The stroke of the outer double action slide is 2 inches, while the



Multiple Slide Press.

stroke of the inner double action slide is 4 inches, as are also the strokes of the single action slides. The total weight of the press, as illustrated, is 12,500 pounds. It is one of the products of the E. W. Bliss Company, 5 Adams Street, Brooklyn, N. Y.

A NEW HIGH PRESSURE BLOWER.

The machine which is illustrated in the accompanying cuts is a blower designed primarily for furnishing a blast of air at high pressure for melting iron in the foundry cupola. This blower involves in its design and method of operation some very ingenious ideas, and its construction is worth describing in detail.

A description will first be given of the various parts which go to make up the blower. Fig. 2 shows the frame or casing. It consists, as may be seen, of two interesecting cylinders with ports at each side. This casing is accurately bored and faced and has its intakes and discharge openings flanged and tapped for standard pipe fittings. The small and medium sizes are built like the one shown, but for the heavier machines the two axes of the casing lie in the same horizontal plane and the intake and discharge are at the top and bottom of the casing. To the faces of the lower flanges of the casing at either end are bolted the two cover plates shown in Fig. 3. These cover plates have large inwardly extending hubs which form the inner boundaries of the air chambers, as may be seen in the line drawings, Figs. 6, 7 and 8. These hubs, however, do not support the central shaft or come in contact with it, being used merely as filling pieces in the interior of the chamber. In the sides of the cover plate are leakage chambers as they may be called, which perform the double function of lessening the leakage and preventing noise as well, as will be explained when the operation of the machine is considered. Brackets are cast to the cover plates to form the outboard bearings of the shaft which carries the impeller. This impeller, shown in Fig. 4, does the real work of compression. It consists of a disc mounted in the center of the shaft, carrying three diamond-shaped bars. This disc fills the space between the ends of the two hubs on the covered plates shown in Fig. 3 which come closer together than is shown in the cut, and leave just room for it to revolve with a reasonable amount of clearance. The impeller bars, as may be seen in the line drawings, span the distance between the interior hub and the external casing and thus force the air through the machine as they revolve. Within the upper part of the casing revolves the idler shown in Fig. 5. This is a symmetrical casting and has a periphery which is nearly a complete circle. It consists of three blades cast in one piece with the shaft, is very rigid, and is rotated by gearing. It is revolved at the same speed as the impeller in the lower part of the casing. These rotating parts are all

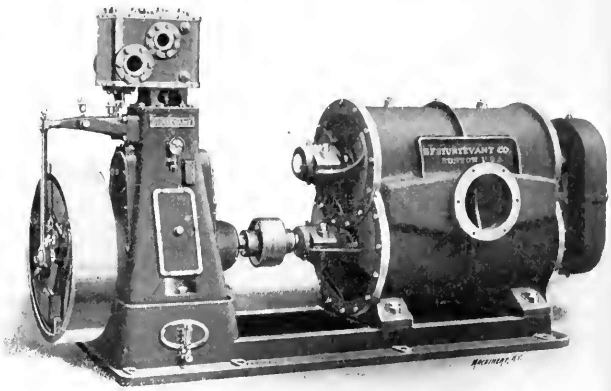


Fig. 1. Sturtevant High-pressure Blower.

symmetrical and are all given considerable clearance, so that no obstacle is offered to the use of high speeds in the operation of the blower. Between the idler and impeller the space is so great that not even an excessive variation in the accurate running of the gears will allow the two rotors to come in contact. This clearance is at least 1/8 inch in the smallest blowers, and in the larger sizes ranges from 1/2 to 3/4 inch. The gears which rotate the idler run in oil and are encased for protection against dirt and accident.

The line cuts, Figs. 6, 7 and 8 will explain the operation of the machine. In Fig. 6, *A*, *B*, and *C* are the impeller blades, *D*, *E*, and *F* are the spaces between them, *X*, *Y*, and *Z* are corresponding chambers formed between the vanes of the idler, and *L*, *M*, *N*, and *O* are leakage spaces in the upper and lower

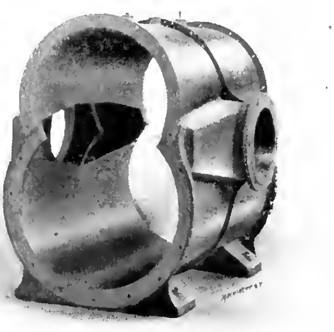


Fig. 2. The Frame or Casing

covers of the casing. The impeller blades are revolving in the direction shown by the arrows so that the intake is at the left and the discharge at the right. With the parts in this position chamber *L* is in communication with the atmosphere and chamber *M* is connected with the pressure main, so that the one is under atmospheric pressure while the other has pressure equaling that of the air delivery pipe. In the idler, chambers *X* and *Z* are also connected respectively with the atmosphere and delivery opening, while chamber Y is cut off from communication with either. When the parts have rotated a little further to the position shown in Fig. 7 chamber *D* between the impeller blades *A* and *B* has been isolated from communication with either opening while blade *C* has entered

chamber Z in the idler. The basic principle on which the mechanism operates will now be apparent. The available volume of chamber Z with its inclosed impeller is considerably less than that of chamber D, thus, while a certain amount of air is removed from the delivery side as the impeller makes each third of a revolution, so much more is brought in by the impeller blade that there is a constant flow of air under pressure from the intake to the exhaust.

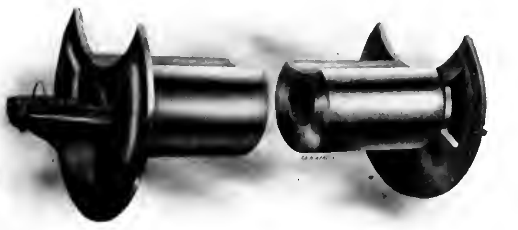


Fig. 3. The Cover Plates.

The air in chamber Y, as will be explained later, is at a pressure intermediate between that of X and Z in Fig. 6. If now, as is about to happen in Fig. 7, communication is suddenly opened between the discharge pipe and chamber Y, the greater pressure in the pipe will cause a sudden inrush of air to the space Y which will cause a sharp explosion or report something like that which occurs when one bursts a paper bag filled with air. But it will be noted in Fig. 7 that before this can occur clearance or leakage space O has opened up communication between Y and Z in such a way as to gradually bring the pressure in Y up to that of the air discharge. It also serves in some measure to reduce the pressure in Z and thus reduce the amount of air which is lost by being carried back under the pressure to the inlet. In Fig. 8 this idea is carried still further and a second leakage chamber N is used to save some of the high pressure air in chamber Z by transfering it to X through leakage passage N. This again serves to reduce the noise which is a feature of the operation of many blowers by gradually reducing the pressure of Z to nearly that of the atmosphere. A further movement of the machine brings impeller C out in front of the inlet pipe to a position corresponding to that of A in Fig. 6. Spaces L and M in the lower cover perform similar functions to N and O so far as rendering the machine more nearly noiseless is concerned. With the machines operating in the direction indicated, M is the only one which has any effect, chamber L being provided only to make the mechanism symmetrical so that it may be run in the opposite direction if desired. If this were done L would be operative and M idle. In Fig. 8 it will be seen that impeller B is about to move forward to a position where passage M will open up communication between high pressure space E and the atmospheric pressure in chamber D. This serves, as in the case of the passages above, to gradually bring the pressure in the two chambers to equilibrium instead of suddenly opening up communication between them. To carry out this purpose still further it will be noted in Fig. 2 that the inlet and discharge ports have a diamond shape outline while the impeller and idler vanes are rectilinear, thus communication is opened more gradually than would be the case if the outlines of both were parallel.

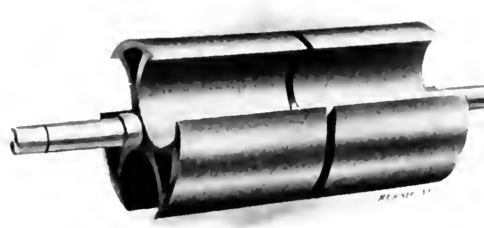


Fig. 5. The Idler.

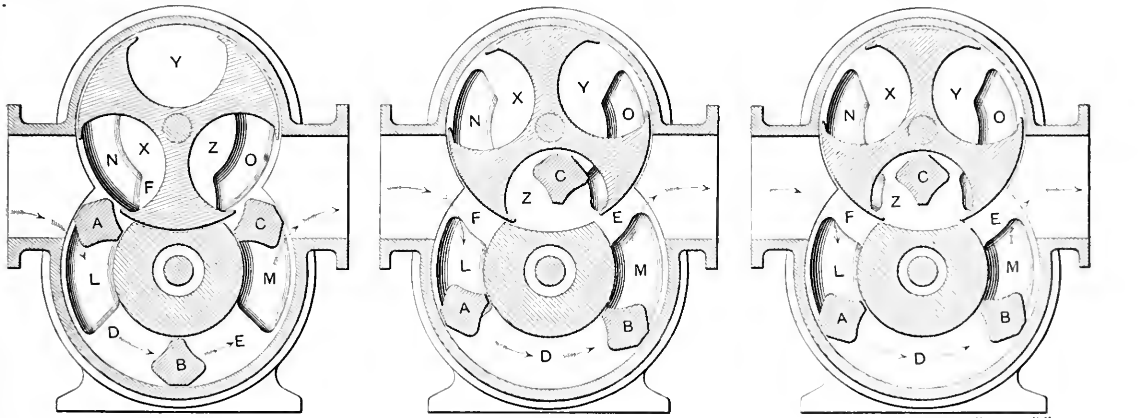


Fig 6 Fig 7. Fig. 8.

Cycle of Operation in One-third Revolution.

The B. F. Sturtevant Co., of Boston, who manufacture this blower, build it in sizes for use with cupolas melting from one to thirty tons of iron per hour. This is based on the assumption, which appears to be sustained in practice, that about 30,000 cubic feet of air are required to melt a ton of iron. The blower runs at from 200 to 450 revolutions per minute, depending on its size. The pressure of the air delivered depends on the resistance offered to its free escape.

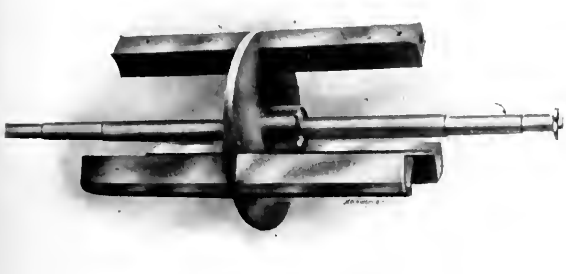


Fig. 4. The Impeller.

A MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE.

Figs. 1, 2 and 3 show front elevation and cross sections of a recently designed automatic screw machine; as may be seen it is of the multiple-spindle type in which the tools are held in a circular row of holes in a knee or slide which feeds them to the work, while the bars of stock are held in rotating spindles which may be indexed to bring them successively opposite the various tools which act upon them. At the right-hand end of the machine in Fig. 1 will be seen the two pul-

leys by which the spindles in the rotating head are driven. The outer and larger of these drives a shaft which extends the length of the machine and rotates the work spindles for threading. The smaller and inner pulley is connected to a sleeve which encircles the shaft before described, and from this rotating sleeve the spindles derive their movement for turning, cutting off, etc.

Fig. 2 will show the way in which the spindles are driven. The outer end of the spindle is here shown broken off; the stock-feeding spool and the jaws for operating the spring collet are of the construction used in practically all automatic screw machines and therefore need not be particularly described. Only one of the five spindles contained in the revolving head is shown in the cut. Gear *K* is keyed to the center sleeve *M*, driven by the smaller of the two driving pulleys before mentioned, while gear *N* is fastened in a like manner to center shaft *O*, which runs in the other direction. These two gears run respectively their mating gears, *L* and *S*, which are loose on bronze sleeve, *Q*. Between them is a clutch cone, *P*, which is keyed to the spindle *R* through the bronze sleeve, and may be thrown into engagement with either one of them by means of yoke *T*, which is pivoted in spider *U* and is operated by a lever actuated from one of the cam drums. When this lever is thrown to the right cone *P* connects gear *L* with the spindle and the work revolves in one direction for turning etc. When yoke *T* is thrown the opposite way a spring clutch pin connects the spindle with the other gear *S*, so that the work is reversed for threading. Three springs, *V*, located

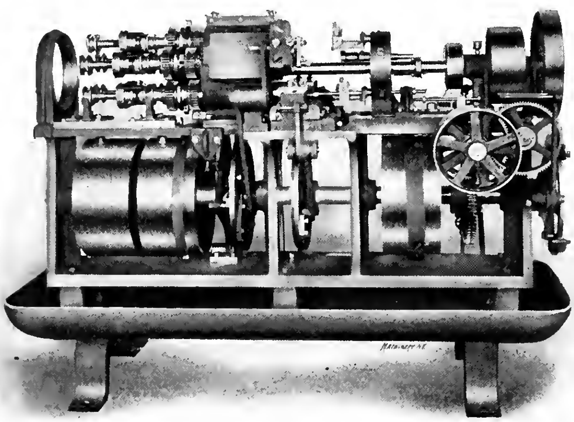


Fig. 1. Multiple Spindle Automatic Screw Machine.

in drill holes in *P*, give the tension for the friction drive, and a pawl, not shown, holds the cone when the block, *W*, is engaged with the spring pin in *P*.

In a machine of this type the keeping of the spindles in alignment at equal distances from each other and the axis of the revolving head is a matter of prime importance. Much depends upon the accuracy of the original workmanship. It is comparatively easy to get the spindles an equal distance from, and parallel to, the center line, within reasonable limits, but to keep them so after the spindles have been running for some time and the boxes have begun to wear is a more difficult matter. Trouble on this score has been minimized in this machine by reversing the usual journal and bearing arrangement. As may be seen, the spindle revolves in taper boxes. These boxes are, however, of hardened and ground steel, while the journal sleeves on the spindle are of phosphor bronze; the wear will thus be evenly distributed on the softer rotating part, while the stationary member on which the alignment depends will be affected to a comparatively slight extent.

Referring again to the half-tone it will be seen that the machine is controlled by a cam shaft running through the base which carries the discs and drums which, with their attached parts, govern the movements of the various slides, spindles, etc. This cam shaft is driven by a quarter-turn belt from the countershaft onto pulleys at the front of the machine, as shown in Fig. 1. There are three pulleys side by side at this

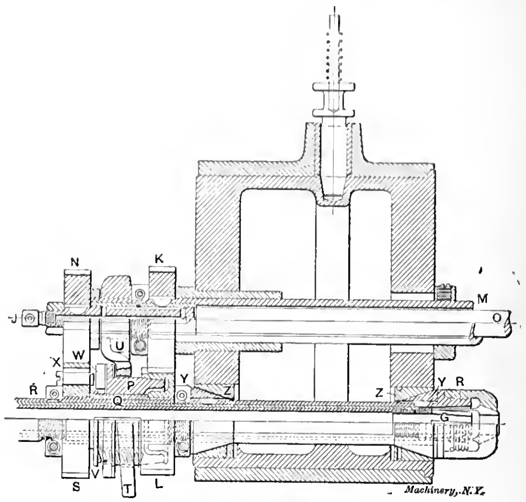


Fig. 2. Section through Spindle showing Driving Mechanism.

point, one each for fast and slow motion, and an idler to which the belt may be shifted when the machine is stopped. The idler is the inside pulley, thus making it possible to operate the machine by hand with the countershaft and the oil pump still running. The belt is shifted from the fast to the slow pulley, or *vice versa*, by dogs on the disk at the extreme right of the machine in Fig. 1. The reduction in speed is made through back gears which may be seen near the pulleys; when these gears are not in use a ratchet arrangement allows them to remain at a standstill. The fast movement is used for all the operating and idle motions of the cam shaft—for everything in fact except the actual feed movements; bringing the tools up to the work, revolving and indexing the spindle head, feeding stock, etc., can all thus be done at a maximum speed irrespective of the slow movement required for feeding.

Looking at Fig. 1 as before, next to the left of the worm wheel by which the cam shaft is rotated comes the drum which actuates the slide to which the box, turning tools, hollow mills, taps or dies, etc., are attached. This is in the

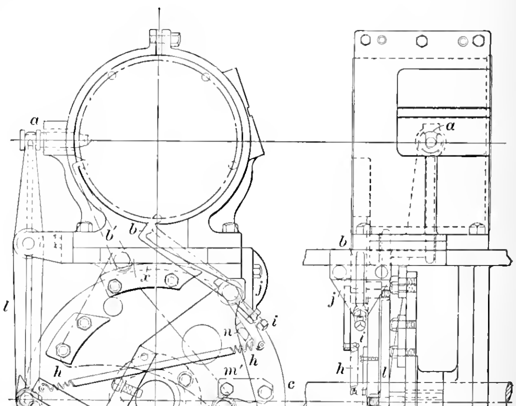


Fig. 3. Indexing Mechanism.

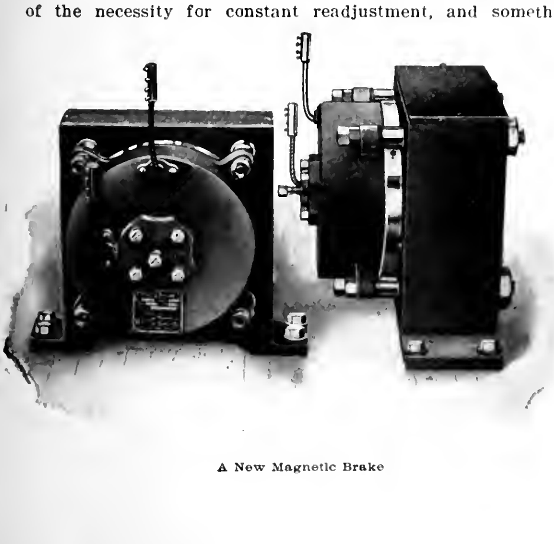
form of a knee with a circle of holes for five tools. A very simple releasing mechanism is provided for use with the tap or die. The arrangement is such that the holder revolves with entire freedom when the thread has been cut to the desired distance.

Next to the cam drum which feeds the turning tools come the cams which operate the two cross slides; these are generally used for forming, or other similar operations, a third slide, mounted on the spindle head, being used for cutting off.

The next mechanism in order, that directly under the cylinder which carries the spindles, is shown more clearly in Fig. 3. These cams, levers, etc., index the spindle cylinder and lock it in position for each new cut. In the rear of the cylinder five holes are drilled near the edge and half way between the spindles. These holes are milled out on an angle of 45 degrees, making a seat for the indexing hook finger, *b*. The finger is shown in three positions and other parts of the mechanism in two positions in the end view. The last positions represent the finger about to be returned for the new indexing. Upon the cam disk, *c*, are bolted the cam strips which control the rocker arm, *d*, by their action on the two rollers, *f* and *g*. This rocker arm is pivoted at *e*. To this arm is also fastened the steel strip, *n*, which carries one end of spring *h*, whose other end is fastened to a continuance of the finger, *b*. In getting a maximum output from the machine it is necessary to reduce the time taken in indexing the spindles to as short a period as possible, and to prolong the life of the machine it should at the same time be done with as little shock as possible. With this end in view the shape of the cam strips which control the indexing is such that the cylinder is started gently from a state of rest, is gradually accelerated to maximum speed, and is then as gradually stopped, bringing it finally to a complete state of rest before the index pin is dropped into place. Finger *b*, being moved by the rocker arm *d* and its cam and rollers, performs the operation of rotating the cylinder. Locking pin *a* being withdrawn by its cam on the disc *c*, arm *e* is thrown to the right. The hook in *b* pulls the cylinder around, bringing it to a stop at the end of its travel when the locking pin is again dropped into position. The fact that pin *b* is limited in its travel by the adjustable screw *i*, which forms the abutment at its heel, makes it possible to stop the cylinder very accurately in the right position, so that the locking pin simply holds it there without having to bring it to the proper location. This makes the wear upon this important part very slight. To withdraw finger *b* from its engaging notch a cam *n*, which is fastened to the inner rim of the cam drum which operates the slide for opening and closing the collet, acts upon the under side of the extension of finger *b*, and tips it out of its seat in the cylinder when the time comes for it to return to its first position.

The drum for collet and wire-feeding mechanism, which is the last in the series, does not differ in its construction and operation from that in ordinary use on machines of this type. The disk next to the indexing mechanism carries dogs which control the action of yoke *T* in Fig. 2, which reverses the spindle at the proper time for threading.

As will be understood from the preceding description, this machine makes a piece complete at each revolution of the spindle. The aim of the designers was to attain simplicity and openness in construction, ease of setting up, elimination of the necessity for constant readjustment, and something better than what had previously been attained in the way of indexing and threading mechanisms, keeping in mind, also, of course, the necessity for turning out accurate work in the shortest possible time. No more tools are required for this machine than for other single spindle machines. On the other hand it is possible to use a great many more tools than on the ordinary type of machine if they are necessary, thus giving it a greater range, and at the same time producing the work more rapidly. This automatic screw machine is the joint product of Mr. Christopher M. Spencer and Mr. R. Hakewessel, both of whom are well known in the screw machine field. It is built by the Universal Machine Screw Co., Hartford, Conn., and can be at present furnished in two sizes, taking work up to ¾ inch in diameter by 5 inches long.



A New Magnetic Brake

NON-OVERFLOWING PUMP AND TANK.

The accompanying half-tone shows an oil tank and pump made by the Delphos Can Co., Delphos, Ohio, for service in mills, shops, etc., or in any place where receptacles of various sizes are required to be filled with oil. The especial point of interest possessed by this device is the use of the double spout, one side of which is an inlet and the other an outlet. In operation, this double spout is inserted in the mouth of the oiler and the pump operated. The delivery spout is somewhat longer than the return. As soon as the oil level reaches the

Non-overflowing Oil Tank.

bottom of the return side of the spout it is siphoned back into the tank as fast as it is delivered. It can be operated in the dark and without soiling the clothing or hands. The tank is made in three, five and ten-gallon sizes. A longer pump is furnished for use with large tanks; in this case the siphoning action is not depended on for bringing the oil back, three pumps being used in all, one of which lifts the oil from the tank, while the other two are used to return the surplus. This device has been on the market a comparatively short time, but has been the subject of numerous repeat orders from customers who have tried it.

MAGNETIC BRAKE.

In the half-tone below are shown two views of a new magnetic brake. The braking action is obtained by means of a series of plates which are alternately keyed to the shaft and suspended from the frame. The rotating plates are circular in shape and are free to move longitudinally. The stationary members are secured and prevented from rotating by studs at the four corners of the base, being also free, however, to move longitudinally. These are all submerged in a bath of oil, thus keeping the coefficient of friction equal, and making the braking force a definite and constant quantity, besides furnishing a means for carrying away the heat from the friction surfaces and radiating it from the entire exterior of the case. The braking force may be adjusted by screwing in or out the adjusting screw in the center of the spring cover.

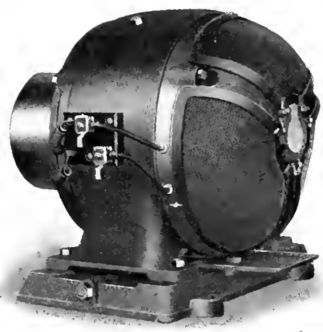
The coil of the magnet is wound thoroughly, insulated and treated with an impregnating process which converts the copper insulation into a solid moisture-proof and heat-conducting mass. The lubricating oil is placed in the case to a depth of ½ inch below the lowest point of the hub opening, and an

oil sling prevents it from escaping. The friction plates throw it to the top of the case, from which it drops to the stationary plates, effectually lubricating them. Weather protection is provided, from the fact that the coil is entirely inclosed, as are also the working parts of the brake. All the parts are machined from jigs and are made on the interchangeable plan. This brake is built by the Electric Controller and Supply Co., Cleveland, Ohio.

NEW LINE OF SPRAGUE MOTORS.

The Sprague Electric Co., New York, whose round type of motor is well known to users of electrical machinery, has recently developed and put on the market a new line of type D direct-current motors. The half-tone below shows as an example of this line, a motor of the horizontal six-pole semi-enclosed type, with covers held by spring latches.

The yoke is of cast steel, in all sizes except the three largest, where it is made of a good cast iron of uniform quality. The poles are of laminated sheet steel punchings and the field windings are substantially taped, treated with a moisture-proof compound, and baked. These coils are interchangeable. The armature core is also built up of thin notched punchings of special steel selected for its low loss by magnetic hysteresis. These punchings are assembled and keyed on the shaft, or to cast iron spiders, depending on whether the motor has four or six poles. The core is ventilated by transverse air passages which permit a circulation of air through the core windings and commutator. The armature windings are shaped on formers and insulated individually before being assembled on the armature core. Wire bands are used over the end windings to retain them in position. The completed armatures are dipped while hot in an insulating and moisture-proof compound and then thoroughly baked. The commutator is built up of a relatively large number of segments, with windings and brush holders so designed to secure cool operation and give good commutation. The bars, which are of hard, drawn copper segments, are carefully insulated from each other and the clamping rings, by mica insulation of a quality selected to wear evenly with the copper.

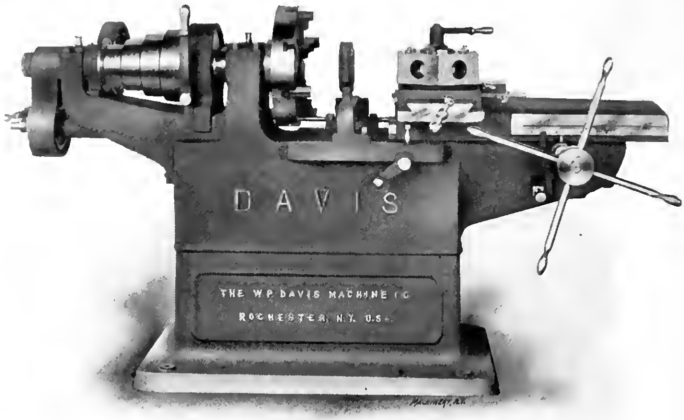


Sprague Type D Direct Current Motor.

These motors may, of course, be built with special frames to suit special conditions. They are made regularly in the open, semi-enclosed, or entirely closed form, with nine different sizes of frames, ranging from 10 horse power to 90 horse power for standard slow speeds, and from 15 horse power to 105 horse power for standard moderate speed motors. They are supplied with either shunt or compound field windings for use on 115, 230 or 500-volt direct-current circuits.

TWENTY-FOUR INCH BORING LATHE.

The W. P. Davis Machine Co., Rochester, N. Y., have made some recent changes in the design of their turret boring lathe, as may been seen by referring to the accompanying half-tone. The machine is driven by a four-step cone through friction gearing which, in combination with a double speed countershaft, gives a total of sixteen speed variations to the spindle. A 3-inch belt is used. A new feature with this design is the use of a cross slide for carrying the turret, this slide being operated either by hand or by power as may be desired. This feed is used for facing or forming of almost any description by fastening forming tools on the various faces of the turret. There are six changes of feed which may be altered instantly and thrown out automatically. A bushing support is provided between the turret and the chuck for use in steadying boring bars; by loosening a single bolt this may be swung back out of the way when not in use. The machine swings 24 inches, has a 2-inch hole through the spindle, and has a net weight of about 3,200 pounds.



Davis Boring Lathe with Cross Slide.

BAKER CAR-WHEEL BORING MILL.

Baker Bros., Toledo, Ohio, have recently built a car wheel boring machine which embodies some points of interest. A general idea of its construction may be gained from Fig. 1, which shows it to consist of a rotating table furnished with chuck jaws, a vertical ram for holding a stationary cutter bar, and a supplementary cross slide for facing. This slide is adjustable for height and carries a bushing for supporting the cutter bar. A suitable range of feeds is provided and the ram is fitted with an automatic stop.

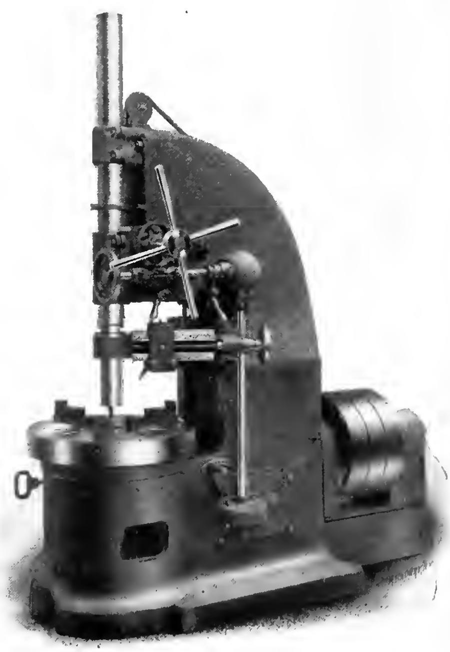


Fig 1. Baker Car-wheel Boring Mill.

A novel feature of the machine is the arrangement provided for varying the speed of the table. A two speed countershaft is used and this, in combination with the three speed mechanism incorporated in the machine gives a range of six changes without clutches or frictions. As may be seen from the half-tone and as is plainly shown in the line cut Fig. 2, the change in the machine is obtained by shifting the driving belt onto either one of the three driving pulleys provided. When the belt is running on the central pulley *A* the drive is direct. Pulleys *B* and *C* are mounted on quills on driving shaft *D*, these quills having teeth cut on their outer ends to form pinions meshing with gears *E* and *F*; these latter in turn, through gears and the shafts on which they are mounted, drive the ratchet members *G* and *H*. The ratchet connection provided at this point is of the silent type. If the belt be shifted to pulley *B* the spindle is no longer driven by pulley *A* but through the gearing at the left of the sketch; similarly if the belt be shifted to pulley *C*, the spindle is then driven by the gearing at the right-hand end of the sketch. In either

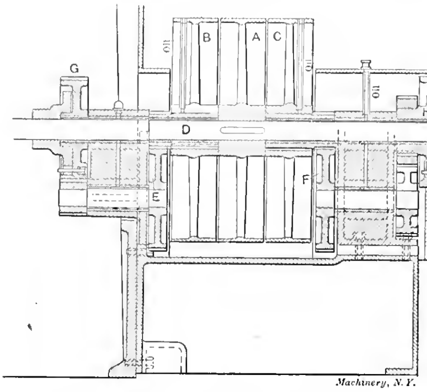


Fig. 2. Section through Driving Pulleys.

case only that train of gearing is in motion which is directly driven by the belt. This mechanism thus provides three speeds, of which the fastest is driven by pulley *A* and the slowest by pulley *B*. It might be thought that in shifting from the low to the intermediate speed, in which case the belt passes across the high-speed pulley *A*, that the machine would be momentarily speeded above the point desired. This condition does not occur, being prevented by the ease by which the belt is shifted, and the fact that the slip of the belt, due to the greatly increased power required for accelerating the speed, prevents it from materially changing while the belt is passing the central pulley. Combined with a large spindle in adjustable taper bearings, with its thrust take upon a large roller bearing, this drive makes a large percentage of the belt power available at the cutting tool.

* * *

The process of making watch dials having the small dial for the seconds hand sunk as is the fashion in modern watches, is interesting in several respects, particularly the method of cutting away the dial for the sunken part. Watch dials are made of copper covered on the face with enamel, usually white, baked on. The enamel is applied in several coats, one being applied after the printing is done, so as to preserve it from being worn off. A sunken dial is made in the same way as a plain dial in the first stages, a plain flat disk of copper being used which is enameled and printed but after this work has been completed a disk of the diameter of the seconds dial is cut out where the sunken dial is to be located. To cut copper with tools and avoid cracking the enamel has been found to be impracticable, so the method followed is to drill through the enamel, using a hollow drill and abrasive the same as when drilling glass. But when the surface of the copper beneath the enamel is reached the drilling is discontinued and the narrow annular space in which the copper is exposed is filled with strong acid which soon eats through the copper, causing the disk to drop out. A small plate representing the second dial, which has been enameled and printed, is then soldered on the back over the hole, thus making a dial with the seconds dial sunk below the face of the main dial.

FRESH FROM THE PRESS.

PRACTICAL PATTERN MAKING. By F. W. Barrows. Published by the Norman W. Henley Publishing Co., New York City. 326 12mo. pages illustrated. Price, $2.00.

This is one of the best treatises on pattern making that has appeared. It is by an author with many years' experience at the bench. There is a general introduction on pattern making as an art, followed by a section on material and tools, taking up subjects like lumber, varnish, hand tools, band saws, circular saws, etc. Then follows a section devoted to examples of wood patterns of different types, and one upon metal patterns. There is then a section upon pattern shop mathematics and one upon cost, care and invention. The author has been very brief and concise in handling the different subjects, which on the whole we think is a good feature.

ELECTRIC WIRING DIAGRAMS AND SWITCHBOARDS. By Newton Harrison, instructor of electrical engineering in the Newark Technical School. Published by the Norman W. Henley Publishing Co., New York. 272 12mo. pages. Price, $1.50.

The contents of this book cover the fundamental facts of wiring from both the theoretical and practical standpoint, calculated to give the student and reader a mastery of the principles of wiring. The elementary relationship of volts, amperes and ohms is given the first consideration; then the drop of potential is considered and means of calculating the drop, finding circular mills and arriving at the numbered gage size for wire are explained. The subject is further expanded from a simple circuit to those of a more complex type and then the principles of switchboard design are considered with reference to shunt and compound wound motors. The book makes an attractive treatise.

PRACTICAL TALKS ON ELECTRICITY. By Wm. Baxter, Jr. Published by the Engineer Publishing Co., Chicago, Ill. 362 pages, illustrated. Price, $2.50.

This book, which is in two parts, is based upon a series of articles originally published under the name of "Prof. Tell" in the columns of *Steam Engineering*. It is intended to explain to the operating engineer or electrician the things he wants to know in regard to electrical machinery used around the power plant. Starting with the elementary principles of electricity and magnetism, the operation of dynamos is explained, switchboards are taken up and measuring instruments are treated, also the controllers and starters for regulating the speed of motors receive attention. No mathematics are used. Unfortunately the book is cheaply printed and bound. Mr. Baxter is known to our readers as an able writer, however, and the contents of his book will be found instructive.

THE INDUSTRIAL PROBLEM, by Lyman Abbott. Published by G. W. Jacobs & Co., Philadelphia, Pa. 150 pages. Price, $1.00.

To some readers this book will seem the expression of radical and dangerous beliefs; other readers will find in it a clear and connected statement of ideas that have been more or less dimly outlined in their own minds. The writer's position is so well assured that anything he chooses to say or write demands and receives careful attention. The beliefs and prophecies outlined in this book are the result of study and observation of the industrial problem, definitely pursued for a period covering nearly thirty years, during which time this study was made one of the chief aims of the author's life. The book will be of interest not only to the sympathetic reader, from the clearness and perspective given to the views discussed, but it will be of value as well to the man who sees nothing but danger in the new beliefs and ideals that are expressing themselves in our modern life, being, as it is, the strongest presentment of these beliefs that has come to our notice.

MODERN MACHINE SHOP CONSTRUCTION, EQUIPMENT AND MANAGEMENT. By Oscar E. Perrigo. Published by the Norman W. Henley Publishing Co., 132 Nassau St., New York City. 343 quarto pages with over 200 illustrations. Price, $5.00.

Mr. Perrigo is well-known to the readers of MACHINERY as the author of articles upon machine shop construction and equipment that appeared in our columns two years ago. These articles and another series upon machine shop management form the basis of this book. The matter has been thoroughly revised since publication however, very largely added to, and the book, as now issued, constitutes a comprehensive treatise upon the machine shop and its management and equipment, which includes also subjects on industrial betterment and mutual aid associations for employees. The book is handsomely printed, bonnd and illustrated. Mr. Perrigo is a clear writer and his work is free from padding.

The part devoted to shop construction considers the various details of the building from the foundation to the roof; the part on shop equipment, the fitting out of the drawing room, foundry, pattern shop, forge shop, etc.; while the section devoted to shop management outlines a comprehensive system showing blanks to be used and takes up in order the management of the different departments. This section is opened by a graphic chart showing an excellent "Shop tree" tracing the responsibility of the different heads of departments from the directors down.

NEW TRADE LITERATURE.

Roofing Rules is the title of an interesting booklet published by the Merchant & Evans Co., Philadelphia, Pa. It gives directions for applying and protecting metal and other kinds of roofing material.

THE NEW ERA MFG. Co., Kalamazoo, Mich. Booklet telling "All About Babbitt Metal." This treats of physical properties, resistance to crushing strain, elastic tension, tensile strength, resistance to heat, etc.

THE HAMILTON MCH. TOOL CO., Hamilton, O. New planer and shaper catalogue No. 5, illustrating and describing planers and shapers of recent design. The descriptions include planers from 24x24 inch to 72x72 inch.

BUCKEYE ENGINE CO., Salem, O. Catalogue of Electric Blueprinting Machines describing their various parts, action, prices, etc. Also booklet entitled "In Vaudeville," telling of the appearance of the company on the "public stage" and their success thereon.

THE CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 62 entitled Electric Hoisting Machinery, giving a general description of electric hoisting machinery, advantages of using, etc., and describing and illustrating several standard types.

THE BROWNING ENGINEERING CO., Cleveland, O. Bulletin No. 21 treating of Grab Buckets. A number of illustrations show the construction and operation of these buckets. Also Bulletin No. 22 devoted especially to locomotive cranes.

WALLACE SUPPLY CO., 905 Garden City Block, Chicago, Ill., new Bending Tool Catalogue. Various bending tools are described and illustrated and samples of work done on these machines are shown. The inside cover is devoted to testimonials, which the firm has received from some of their customers.

THE S. OBERMAYER CO., Cincinnati, O., issue a foundryman's bulletin which they will send free to any foundryman in the world. Notices of help and positions wanted, foundry machines for sale, and other items of interest are seen in its pages. The latest number contains articles on Modern Tools in a Foundry, The Art of Making a Core, Dry Sand Blacking, Operating or Management of a Cupola, Foundry Illumination, etc.

MACHINERY.

March, 1906.

PATENTS IN THEIR RELATION TO THE GAS ENGINE AND THE AUTOMOBILE.—2.

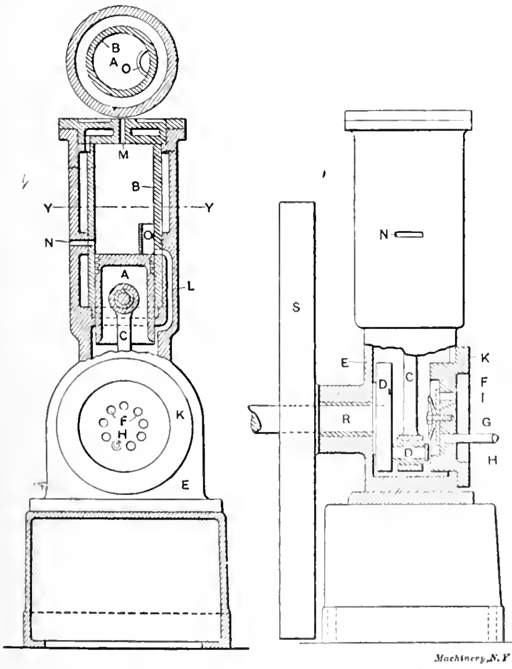
S. M. HOWELL.

In the January article of this series we referred to the English patent of J. Day, as the first complete embodiment of the modern two-cycle engine. There are, however, two Day patents and also those of two other inventors, all of which are very similar in design, differing only in certain details which will readily appear to the reader upon an inspection of the drawings. These original two-cycle patents are five in number; two, by J. Day, dated in England April 14, 1891, and in the United States July 30, 1895, and August 6, 1895; one by F. W. C. Cock, dated in England October 15, 1892, and in the United States August 6, 1895, naming J. Day as assignee of the entire interest; one by C. Sintz, dated November 21, 1893; and one by L. H. Nash in 1888. The drawings and specifications of the first four are given below and the Nash patent will be taken up later.

First Patent of Joseph Day.

In the drawings, Fig. 1 is an end view, partly in section, of a gas or vapor engine of the vertical inverted type, in which the crank works in an inclosed space in the framework. Fig. 2, above Fig. 1, is a plan section on line *Y Y*, Fig. 1. Fig. 3 is a side view partly in section.

Referring to Figs. 1, 2, and 3 the plunger or piston *A* reciprocates in the jacketed cylinder *B*, which is mounted over and connected by a connecting-rod *C* to the crank-pin *D*, which latter is mounted on the crank or crank-disk D_1 keyed onto crank-shaft *R* having fly-wheel *S*. The air and gas are drawn in from below through the casing forming the admission-



Figs. 1 and 2. Fig. 3

Patent of J. Day, July 30, 1895.

chamber *E* respectively by air-ports *F*, communicating to the outer air, and gas-port *G* leading from the gas-supply pipe *H*, and a single disk or other suitable valve *I* does duty for the admission of both air and gas.

The air and gas, as described, enter by the valve *I* during the early portion of the upstroke and by the revolution of the crank-disk D_1 and crank *D*, and movement of the connecting-rod are intimately mixed. The explosive mixture is conveyed into the upper part of the cylinder at the end of the down-stroke or early part of the up stroke by a passage *L* in the outside of the cylinder, while the piston itself serves as a slide-valve whereupon the compression of the mixture above begins, owing to the piston closing the port and thus preventing communication between the upper and lower parts of the cylinder. The ignition then takes place by any suitable igniting device having connection with the interior of the cylinder by a pipe *M*, and the plunger *A* is forced down until the exhaust-port *N* is uncovered thereby, and the majority of the products of combustion escape, while previous to such exhaust

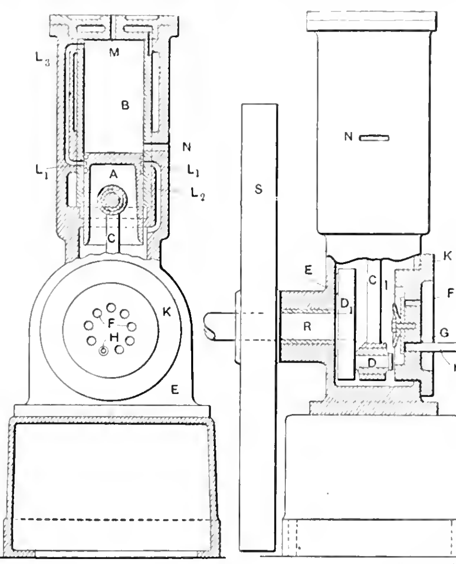


Fig. 4. Fig. 5.

Patent of J. Day, August 6, 1895.

a certain amount of compression has been given to the mixture of air and gas below in the chamber *E* in such manner that, as aforesaid, as soon as the exhaust has taken place the explosive mixture passes by way of the passage *L* into the upper part of the cylinder.

By so proportioning the size of the exhaust-port orifice, I am enabled to leave more or less of the products of combustion in the cylinder at the end of the downstroke, as desired. In order that the explosive mixture may not at the beginning of the upstroke escape by the exhaust, I provide a sort of funnel, shield, or deflector *O* on the top and at one side of the plunger, or otherwise I may make the port of the passage *L* in such manner that the explosive mixture is directed away from the exhaust-port. The cubical contents of the inclosed lower chamber and the cylinder should bear such relation to one another that, on the charge being delivered into the cylinder from the lower chamber *E*, both sides of the plunger should be at or about at atmospheric pressure.

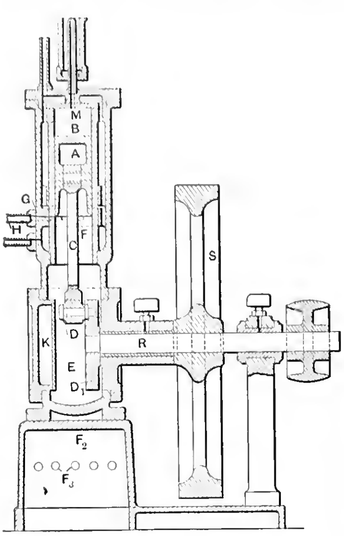
Lubrication of the working parts and the keeping cool of the same are attained by permitting one or more of such parts to move or impinge against oil or water, or a mixture of both, in the bottom of chamber *E*. The speed of the engine may be governed by means of any suitable governing device acting on the gas-supply or otherwise.

By reason of the direct flow of the explosive mixture through the passage *L*, it becomes possible, as evidenced by actual practice, to produce with absolute certainty an ignition at each revolution, and to run the engine at a speed of as much as five hundred revolutions per minute. This has heretofore been impossible.

Second Patent of Joseph Day, Figs. 4 and 5.

The air and gas, as described, enter by the valve *I* during the early portion of the up-stroke, and by the revolution of the crank-disk D_1 and crank *D* and movement of the connecting rod are intimately mixed. The explosive mixture is conveyed

into the upper part of the cylinder at the early part of the up-stroke by the passages L_2 and L_3 and annular groove L_1 in the plunger, whereupon the compression of the mixture above begins, owing to the groove L_1 in the plunger ceasing to register with the ports of the passages L_2 and L_3, and thus closing automatically the connection between the upper and lower parts of the cylinder. The ignition then takes place by any suitable igniting device having connection with the interior of the cylinder by a pipe *M*, and the plunger *A* is forced down until the exhaust-port *N* is uncovered thereby, and the ma-



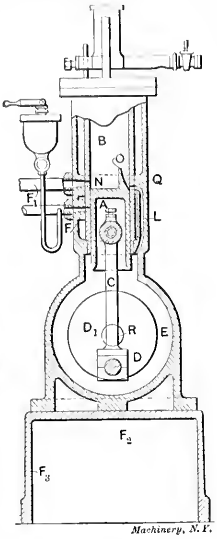


Fig. 6. Fig. 7.

Cock Patent, August 6, 1895.

jority of the products of combustion escape, while previous to such exhaust a certain amount of compression has been given to the mixture of air and gas below in the chamber *E* in such manner that, as aforesaid, as soon as the exhaust has taken place the explosive mixture passes by the passage L_2, groove L_1, in the piston or plunger *A*, and by the other passage L_3 into the upper part of the cylinder. By this means I attain that the explosive mixture reaches the upper part of the cylinder and away from the exhaust-port, so that the incoming charge does not escape thereby and cause a waste.

By regulating the size of the exhaust-port orifice I am enabled to leave more or less of the products of combustion in the cylinder at the end of the downstroke, as desired. The cubical contents of the inclosed lower chamber, and the cylinder should bear such relation to one another that on the charge being delivered into the cylinder from the lower chamber *E* both sides of the plunger should be at or about atmospheric pressure. Lubrication of the working parts and the keeping cool of the same are attained by permitting one or more of such parts to move or impinge against oil or water, or a mixture of both, in the bottom of chamber *E*. The speed of the engine may be governed by means of any suitable governing device acting on the gas-supply or otherwise.

Patent of F. W. C. Cock, Figs. 6 and 7.

Fig. 6 is a sectional elevation with the piston or plunger at the top of its stroke, assuming the engine to be vertical; and Fig. 7 is an end elevation, partly in section, with the piston at the bottom of its stroke.

In the drawings, the admission of gas and air is shown as through two separate ports, the air being admitted by the port *F*, while the gas is admitted by the port *G*. These ports, it will be seen, are of considerable width, but of little depth, so that the duration of their opening will be brief, as they will be closed except when the piston is at or near the extreme of its return stroke. The flow of the gas and [or] air or of the explosive mixture may be controlled by any suitable device.

The following is a description of the mode of working this invention: Assuming the piston *A* to be at the top, as shown in Fig. 6, it will be seen that the air and gas ports are uncovered, and are now in free communication with the chamber *E*, in which, at this time, a partially-vacuous condition exists, and the air and gas rush in to satisfy this vacuous condition. At this moment, also, the explosive mixture is in a compressed state above the piston and is driven into the igniting-tube *M*, shown as placed in the top cover of the cylinder, which ignites it in the usual manner, producing the downward or "power" stroke. Almost immediately after the commencement of this downward stroke the gas and air ports are closed by the descent of the piston, which then begins to slightly compress the gas and air mixture, which has been drawn into the chamber *E* below it. By the time that the piston has completed its downward stroke, as shown in Fig. 7, it has uncovered the outlet-port *N*, thus allowing the products of combustion to escape, and it has also uncovered the upper mouth *Q* of the passage *L* forming the communication between the chamber *E* and the upper side of the piston. The products of combustion have, as regards the bulk of them, escaped through the exhaust by reason of their pressure above that of the external atmosphere, and as soon as this escape has lowered that pressure to the condition prevailing in the chamber *E* the mixture passes up the passage *L* into the upper part of the cylinder, coming in contact with the shield or deflector *O*, which is carried on the top of the piston. This shield or deflector prevents the passage of the mixture across the top of the piston and out by the outlet-port, and compels it to rise to the top of the cylinder, passing away from the exhaust-port, thus enabling it to sweep round and chase before it the small portion of the products of combustion remaining in the cylinder. By this time the piston has so far advanced in its upward stroke as to cover the mouth of the exhaust *Q* of the passage *L*. During the ascent of the piston, it will be seen that the before-mentioned partially-vacuous condition in the chamber *E* below it is produced. The cylinder is shown water-jacketed in the usual well-known manner.

Patent of Clark Sintz, Figs. 8, 9 and 10.

In the drawings *a* represents the cylinder, which is provided with an annular water-chamber surrounding the same, in the usual way; *b*, is the piston arranged therein, and connected by a pitman *c*, to the crank *d*, on the main shaft d_1, which shaft preferably extends through the lower portion of the main frame which supports the cylinder and turns in suitable bearings d_2, therein; said shaft being supplied with suitable fly or driving-wheels d_3. The piston *b*, is made of considerable length and chambered out so that the pitman *c* is connected thereto near the upper end or head thereof. Extending through the walls of the piston thus formed is an opening or port *e*.

Arranged in the side of the cylinder and opposite to the port *e*, of the piston, are exhaust and supply ports *f*, *g*, which ports are opened and closed successively and are never open to the cylinder at the same time, one or the other being constantly closed by the piston *b*; the exhaust port *f*, being adapted to open into the upper part of the cylinder just before the piston reaches the limit of its downward stroke, the supply port *g*, being adapted to communicate with the lower portion of the cylinder when the piston reaches the limit of its upward stroke. On the opposite side of the cylinder is a chamber *h*, formed in the walls of the cylinder, which communicates with the interior of the cylinder through ports h_1 h_2 which I will designate as the direct and indirect supply ports. The port h_1, is adapted to communicate with the upper end of the cylinder and above the piston, as the piston reaches the limit of its downward stroke, while the port *e*, which opens directly to the explosive chamber through the walls of the piston, communicates with the port h_2, at the same time,

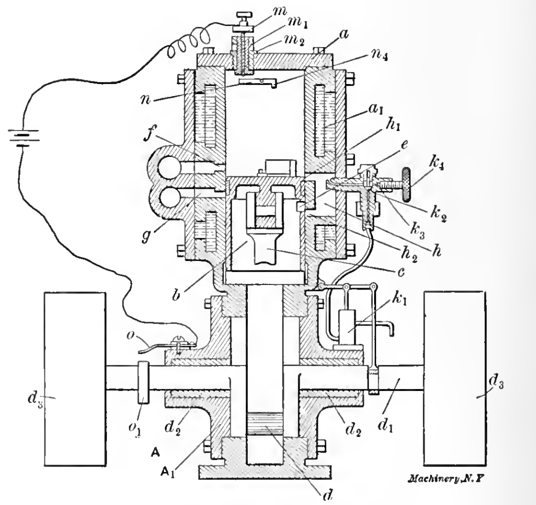


Fig. 8. Sintz Patent, November 21, 1893.

and thus establishes a communication from the lower end of the cylinder to the upper end of the cylinder through the chamber *h*, as the piston reaches the limit of its downward stroke.

The base of the engine *A*, which forms the main frame and supports the cylinder is preferably formed with a chamber A_1, which incloses the crank *d*, and which is completely closed by side plates which support the bearings d_2. This chamber A_1, preferably communicates directly with the lower end of the cylinder which is left open for this purpose.

Arranged on the top of the piston is a curved deflector j, which extends about half way around the said piston, concentric with the periphery of the piston and a slight distance therefrom, said deflector being turned outwardly at each end to form radial projections which approach in close proximity to the inner walls of the cylinder. This deflector stands opposite the port h_1, when said port is opened by the downward movement of the piston, and serves to deflect the air and gases admitted through said port to the cylinider, and causes them to rise upwardly and circulate around the top and sides of the cylinder when so admitted, in the manner hereinafter more fully described.

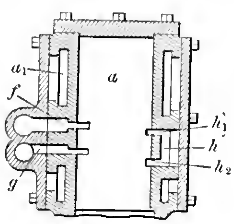


Fig. 9.

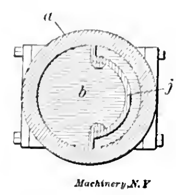


Fig. 10.

At one side of the cylinder and extending into the chamber h, is a supply valve k, through which the gasoline is supplied from a pump k_1, which may be operated from any suitable connection with the running parts of the engine. This supply or gasoline valve k, is provided with a check k_2, which permits the passage of the gasoline into the chamber h, but prevents any backward flow therefrom; it is also preferably provided with an outlet opening k_3, controlled by a valve k_4, by which the presence of the gasoline within the supply valve may be determined. From the check k_2, the gasoline passes directly into the chamber h, through a passage which is preferably inclined at the outer end, to give an upward and outward discharge to the gasoline in the direction of the port h_1.

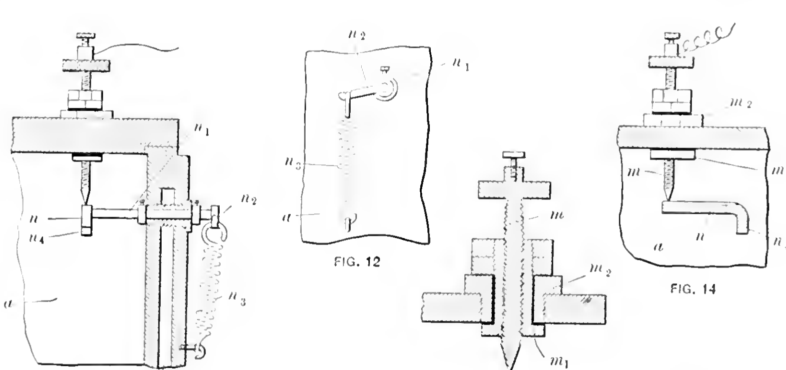
The operation of the device as thus described is as follows: The piston being at the limit of its downward stroke, with the supply port g thus closed by said piston, motion is imparted to the shaft which causes the piston to ascend, thus forming a partial vacuum in the lower end of the cylinder and in the chamber A_1, connected thereto. This continues until the lower end of the piston passes the port g, when the air immediately rushes in to supply the partial vacuum thus formed. As the shaft continues to revolve the piston descends, thus compressing the air in the lower end of said cylinder and in the chamber connected thereto until the port e, comes opposite the port h_2, which occurs simultaneously with the opening of the port h_1, by the upper end of the piston. The air from the lower end of the cylinder, owing to the slight pressure thereon, caused by the downward stroke of the piston, rushes through the respective ports h_1, h_2, in the chamber h, into the cylinder, carrying with it a supply of gasolene, which is introduced through the supply valve at this point in the form of a spray and becomes thoroughly and intimately mixed and impregnated therewith. The port f has, by the downward movement of the piston, been opened, furnishing an exit opening, but the deflector j prevents a passage of the explosive mixture directly through the port f, and causes it to pass upward along the side of the cylinder to the top thereof, and, as the piston immediately begins its upward strok the exhaust port f is closed, and the charge thus introduced is compressed by the upward movement of the piston. Arranged in the top of the cylinder is an electric ignitor or exploder, which consists essentially of an electrode, m, preferably screw-threaded and adjustable through an insulated sleeve, m_1, arranged with a suitable screw-threaded supporting casing, m_2, which screws into the top of the cylinder. Arranged within the cylinder is an oscillating bar n, on the end of a rock-shaft n_1, which is supported in a suitable bearing in the side of the cylinder and is connected on the outside, through the medium of an arm n_2, to a spring n_3, this spring being so arranged that one extremity of the bar n, is held normally in contact with the electrode m. The opposite end of the bar n, is preferably provided with a lug or projection n_4, adapted, as the piston ascends, to come in contact with the top of said piston or with the deflector j, which is preferably employed in this instance for that purpose. This causes the bar n, to be withdrawn from the electrode and produces a spark at this point, just as the piston has reached the limit of its upward stroke, and just as the compression of the explosive charge has been completed. The result is: an explosion follows and the piston is driven downwardly until it passes the exhaust port f, when the products of combustion are discharged. This occurs just prior to the opening of the port h_1, by the piston, the lower end of the exhaust port f, being substantially on a line with the upper edge of the port h_1, so that the exhaust port is wide open at the time the supply port h_1, begins to open. The inrushing charge, which, by the aid of the deflector is given the upward and circulating motion, described, assists in driving out the products of combustion through the exhaust ports, these ports being momentarily open at the same time.

In order to insure the rapid movement of the bar n, away from the electrode and thus the formation of the spark instantaneously, I preferably form the electric contact end of the bar n, considerably longer than the end which contacts with the piston, which causes it to move more rapidly than the shorter end. The electrode m, as before noted, is insulated from its supporting casing and thus from the other parts of the engine. The bar n, is not insulated so that the other electrical connection can be made to any of the metal portions of the engine. To provide for shutting off the battery, except just as it is required, and thus preventing its deterioration, I provide for automatically making and breaking the circuit before and after the spark is formed in the manner described. This I accomplish by connecting one pole of the battery to the electrode m, and the other to an insulated contact device o, secured in any suitable position to the engine and adapted to contact intermittently with one of the moving parts of the engine, so that a connection will be formed therewith just prior to the time that the spark is to be formed, the connection being broken as soon as the spark has been formed. This may be accomplished as shown in Fig. 8, by a cam or eccentric o_1, arranged on the main shaft and adapted to contact with the contact device, o, formed in the nature of a spring just before the spark is to be formed and to be withdrawn from contact therewith just after. The arrangement, however, can be modified, so that it may be applied to any portion of the engine and adapted to contact intermittently with any moving part.

Engine of S. M. Howell, Figs. 15 and 16.

From the above records of these inventions it is quite evident that the first half of the 90th decade marked a period of great activity among inventors of two-cycle engines. Who is entitled to the credit of originating the general features of the system, is a question which we must decide as best we may from the material at hand. Nash's two-cycle patent is the earliest formation of the general idea, and unless we could find earlier records in the patent office, we should therefore award to him the palm of priority.

There are, however, a number of minor points separately covered by these patents, and which may be determined by a study of the drawings, much more readily, indeed, than by



Details of Sintz Engine.

reading the claims, which are largely a mass of conflicting testimony.

Figs. 15 and 16 show a two-cycle engine of simple construction, designed by the author. This style of construction has proved very reliable and efficient, either as a boat, automobile or stationary motor, and being of such varied adaptability may well be termed universal. The figures show this engine in a vertical position, but it may be placed horizontally or completely inverted. The latter position has been very successfully adopted by some automobile manufacturers. An engine thus placed requires but one oil cup. This is screwed into the top (or what would otherwise be the bottom) of the crank

case, and from this single point, sufficiently lubricates the entire mechanism, including the cylinder.

Figs. 17 and 18 with the accompanying specifications describe the Hain three-cylinder engine.

Hain Three-cylinder Engine, Figs. 17 and 18.

Fig. 17 is a longitudinal vertical section of a device embodying my invention, and Fig. 18 a plan view of the same with parts broken away to show the construction.

Like letters refer to like parts in both figures.

The device consists, essentially, of a series of base compression combustible-vapor engines, having a common crank-shaft, with cranks set at such relative angles that the engines act in succession, the charge in the first engine in the series being fired by the usual means and the other charges being fired in succession by the escape of a portion of the charge of the preceding engine through a suitable port connecting the various cylinders of the engines.

A A′ A″ are the cylinders.

B is the intake and firing port of the first cylinder, closed by a check *E* and provided with firing mechanism *D*.

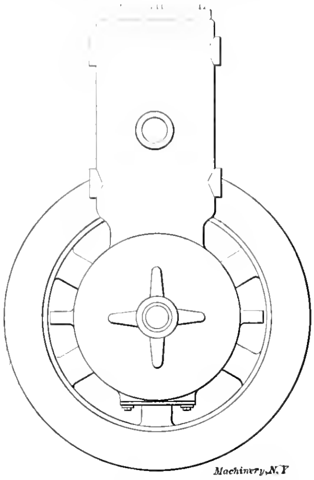


Fig. 15. End View of Howell Engine.

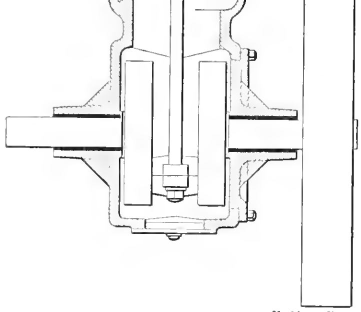


Fig 16. Sectional View of Howell Engine.

B′, *B″* are passages from each base to the upper end of each cylinder, which passages are closed by checks *E″*. The series of cylinders is connected by ports *B″*, provided with checks *E′*. Each port opens into the cylinder first in series at such point that said port will be uncovered by the piston *N* in that cylinder when the piston in the next cylinder is at the beginning of its power stroke. This point will depend on the relative angle at which the cranks *L* are adjusted, which angle is preferably not more than sixty degrees. The other end of said port *B″* opens into the top of the next cylinder in the series. Each cylinder is provided with a piston *N*, connected by a rod *M* to one of the cranks *L* aforesaid. Each cylinder is also provided with an exhaust-port *C*, opened by the descent of the piston to exhaust the charge, and each base also has the usual intake *O* for the incoming charge.

Each check *E* is provided with a stop to hold the same closed, consisting of a screw *K*, adapted to be turned down on said check.

Relief-valves *F* are provided on each cylinder and base, except the first in the series. The one on the middle base is not shown in the drawings. Said valves are each held closed by a spring *I*, engaging a knob *J* on the valve-stem and held open by a pawl *G*, engaging a groove *H* in said stem.

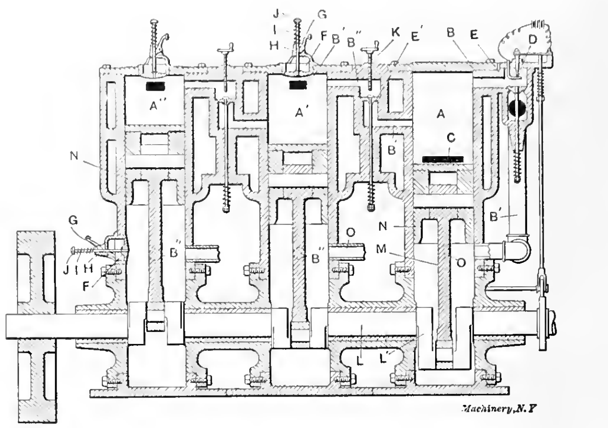


Fig. 17. Hain Patent, February 22, 1898.

The operation of the first engine in the series, when the check *E′* between it and the next one is closed and the relief-valves *F* are all open, is the same as a complete single-cylinder base compression-engine, the other pistons running idle and working air freely through the relief-valves *F*. By closing the relief-valves of the next cylinder and base and releasing the check *E* between it and the first cylinder this second cylinder will take charges through *O* and *B′* the same as the first cylinder. Said charges will be fired as the piston of the first cylinder descends and uncovers the port *B″* by a portion of the charge in the first cylinder escaping through said port. The third cylinder in the series can in like manner be brought into action by releasing its check-valve *E′* and closing its relief-valves *F F*. The drawings show but three cylinders; but it is evident that the series may be prolonged indefinitely. By adding three more cylinders and placing the cranks at sixty degrees apart the cylinders would come into action in succession equidistant around the entire revolution of the shaft, thus making a very steady impulse. Any desired number of cylinders could be thus connected in series and operated as described. Also by the described construction engines of high power may be made that can be started into action in series, as described. By cutting out a part of the cylinders, as described, the power is more economically reduced than by reduced charges in a single large cylinder.

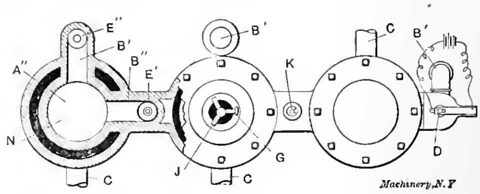


Fig. 18.

* * *

The 200th anniversary of the birth of Franklin was celebrated in some of the larger cities January 17. The scientific work of Franklin in establishing the identity of lightning and electricity is known perhaps as his greatest achievement. The courage required to make the famous kite experiment can scarcely be appreciated at this time. Not only was Franklin in some actual danger of death from lightning stroke but according to the notions of that time he was inviting it by tempting the wrath of the Almighty in doing something very sacrilegious.

WILLANS-PARSONS TURBINES.

In a recent number of MACHINERY was published a description of the new Allis-Chalmers steam turbine and details were shown of several important features, among them being the arrangement of the balancing pistons of the rotors, by which the thrust upon the steps of the drum is balanced.

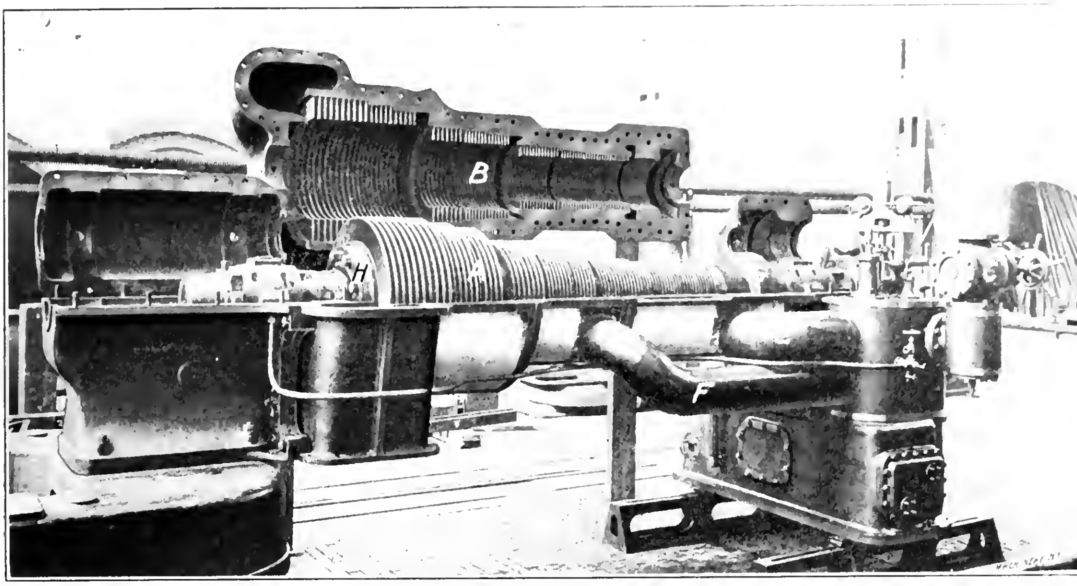


Fig. 1. One thousand H. P. Willans-Parsons Turbine.

We show in Fig. 1 a Willans-Parsons turbine, made by the well-known engine builders, Willans & Robinson, Rugby, England. Its design is similar to that adopted by the Allis-Chalmers Co., since both these firms are members of the Turbine Advisory Syndicate, controlling certain important patents upon the turbine. This illustration shows the construction more clearly than the illustrations of the article in the January number. Referring to the cut, *A* is the rotor and *B* the top of the casing removed to expose the rotor. Steam is admitted through the stop valve *C*, and within the casing at *D* are the valves controlling the admission of steam to both the high-pressure and low-pressure parts of the turbine. The high pressure steam passes through *E*, but in case of an overload a by-pass valve opens and high-pressure steam is admitted through *F* to the low-pressure end of the rotor. It will be noted that there are no valves, piping or valve gear connected with the top of the casing, and that there is therefore none to be disconnected when it is desired to remove the top for examination.

The usual arrangement of the balance pistons in the Parsons turbine has been to have three of different diameters at the high-pressure end, the larger one balancing the thrust of the step at the low-pressure end of the drum. In the present arrangement, however, what correspond to the two smaller pistons only are at the high-pressure end and are shown at *G* in the engraving. The low-pressure piston is at

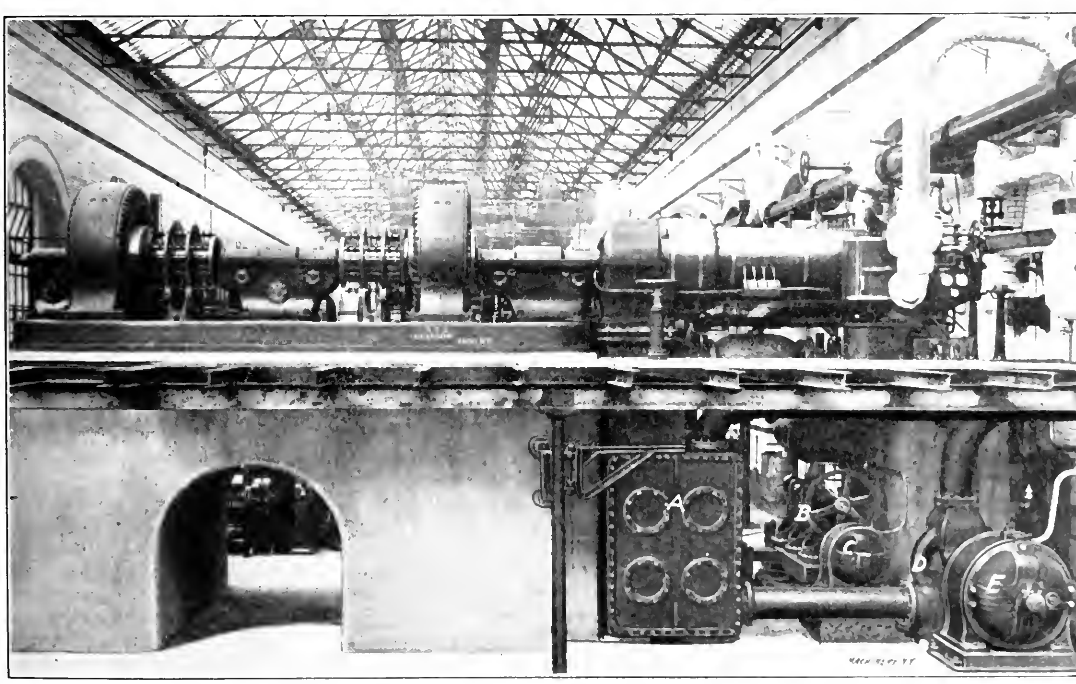


Fig. 2. Two thousand H. P. Willans-Parsons Turbine, Direct-connected to two 700 K W Generators

H at the other end. This piston is so located that nearly its whole circular area is available to balance the thrust, whereas in the other form of construction only an annular area is available due to the difference between the diameters of the largest and next smaller size of piston.

Fig. 2 is a photograph of a 2,000 horse power Willans-Parsons turbine at Glasgow, Scotland, and is of interest because of the excellent view of the condensing apparatus used in connection with the turbine. The condensing equipment is compactly arranged and located in the pit or basement beneath the turbine. The surface condenser is at A. A triple-cylinder air pump, B, of the Edwards type is driven by the motor C, and D is a centrifugal circulating pump driven by the motor E. This equipment is a model in compactness and simplicity of arrangement, compared with many condenser outfits that have been supplied with turbines in this country.

* * *

EARLY BUILDINGS OF THE SKELETON TYPE.

HOWARD A. COOMBS.

I noticed in your August number a statement that the Tower Building on Broadway, New York, was soon to be demolished in order to make room for a new building, and that the said building was the first of the skeleton construction buildings ever erected.

This belief, which is not warranted by the facts, is doubtless owing to the presence of a bronze tablet affixed to the walls of the Tower Building, and purporting to be in commemoration of its being the pioneer of the modern type of office-building construction. The tablet was placed on the building in question in August, 1899, by the Society of Architectural Manufacturers, a New York organization. The society seemed to have relied upon a real estate publication called the *Record and Guide* as proof that the Tower Building was the first skeleton building ever constructed. However, Mr. Bradford L. Gilbert, the architect of the Tower Building was not the originator of the skeleton construction.

The Home Life Insurance Company's Building in Chicago, which was built in 1883-4, was the first example of the skeleton construction and to its architect, W. L. B. Jenney, belongs the honor of being the first to actually construct a tall office building in that way.

A controversy, or rather discussion, for the conclusions were almost unanimous, as to who was the inventor or originator of this type of building, was started in the *Engineering Record* for June 27, 1896, by a letter from F. P. Gates, president of the Bessemer Steamship Company, to the editor, which read as follows:

"Sir: Will you have the kindness to inform me to what architect or engineer the honor is due of discovering and practically working out the idea of lofty steel construction of buildings."

The purpose of this inquiry was to honor the said architect or engineer by naming one of the steamers of the company after him.

In reply a number of contributions were received from prominent architects and engineers and the consensus of opinion awarded priority to Mr. Jenney, and the Home Life Building. However, the said building was not a complete example of what is known as skeleton or veneer construction, as cast-iron columns were used in the main piers, the latter being self-supporting and not carried by the columns. The fact, however, that Mr. Jenney supported the walls and floors of each story independently on the said columns, thus dividing the total movement, due to expansion and contraction, into as many parts as there were stories, entitled the building to be called the first example of modern office building construction.

The second building in which the skeleton construction was used was the Tacoma Building, Chicago, Holabird & Roche, architects. This building was of skeleton construction throughout, the entire outer walls, as well as the floors, being carried by the frame.

An early instance of partial skeleton construction was the New York Produce Exchange Building, erected by George B. Post in 1881, in which the interior courtyard wall was constructed with a cage of cast-iron columns and wrought iron girders, filled with brick panels. A similar construction was used in the court of the Rookery, Chicago, Burnham & Root, architects, 1885-6.

If fragmentary or partial examples are to be considered, we must go even further back than 1881. There is a short tower at 82 Beekman Street, New York, projecting four stories above a three-story building, in which the panels or walls are carried by the framing, which was built about the middle of the last century.

The Broad Street Station of the Pennsylvania R. R. in Philadelephia, erected in 1881-2, had wrought iron columns from the ground floor upward, encased in masonry carrying a second floor, then extending to the third floor and carrying plate girders, on which was built the upper part of the rear exterior wall of the building.

Abroad we have the Printemps store in Paris, built in 1883-4, in which the floors are carried by wrought iron columns, while the outside walls are self-supporting, and the Crystal palace, London, first constructed for the exposition of 1851, in which the walls are of glass carried by the frame-work.

Architect L. S. Buffington, of Minneapolis, claims to be the first inventor and discoverer of skeleton construction. He took out a patent May 22, 1888, which discloses a form of skeleton and veneer construction applied to tall buildings. It is remarkable that, notwithstanding his patent and claim to be the originator—in a letter to the *Engineering Record*, published August 8, 1896, he says the Boston Block in Minneapolis, built in 1881, has a skeleton frame—his name is not even mentioned by any of the other architects who discussed the matter about that time in the said journal.

The writer understands that Mr. Buffington's patent has been acquired by a syndicate and that a number of suits against the owners of buildings were filed shortly before the patent expired last May. That being so, the whole subject is likely to be thrashed out in the courts and the decisions will make interesting reading for those who are interested in the subject.

* * *

The following results secured in a number of boiler plants recently equipped with economizers by the B. F. Sturtevant Co., Boston, Mass., are suggestive of the possibilities in the way of increasing the temperature of feed water and the boiler output without additional expenditure of fuel. Manifestly, such results are equivalent to maintaining the initial boiler output with a decreased amount of fuel.

Plants Tested.	Gases Entering Econ. Degrees.	Gases Leaving Econ. Degrees.	Water Entering Econ. Degrees.	Water Leaving Econ. Degrees.	Gain in Temperature of Water. Degrees.
1	650	275	180	340	160
2	575	290	160	320	160
3	470	230	130	260	130
4	500	240	110	230	120
5	460	200	90	230	140
6	440	220	120	236	116
7	525	225	180	320	140

It is to be noted in this connection that an economizer is capable of producing the best results in connection with a mechanical draft plant. The objection always raised against the economizer is that it reduces the temperature of the gases so much that they are not efficient in maintaining an unbalanced pressure in the chimney, and the draft consequently suffers. With mechanical draft, however, this objection is removed, since the degree of draft is entirely independent of the chimney temperature.

* * *

One of the most beautiful applications of the thermit welding process is that of pipe welding, but it is only recently that any important commercial application of the process was made in this country. The Manhattan Refrigerating Co. in New York City employed it to weld pipes that were laid in the ground on Fourteenth Street; these were used as service return pipes in the delivery of liquid ammonia at 180 pounds pressure which was conveyed to various cold storage warehouses on the street. Twenty-nine 1¼-inch and twenty-seven 2-inch joints were welded. The pipe was first welded into lengths varying from 40 to 100 feet and then rolled into the ditch and there welded into the line, thus making the pipe line one continuous pipe without fitted joints, and the two-inch pipe had only one expansion bend.

VARIABLE SPEED MECHANISMS.—8.

GEARED DEVICES (Continued).

In Fig. 71 is shown gearing for transforming speed which was patented by R. H. F. and A. H. Finlay, February 6, 1900, No. 642,594. This appears to have been designed with reference to the requirements of hoisting apparatus and such use is mentioned in connection with the apparatus. *A* is described as a high-speed shaft carrying two pinions, *B* and B_1, which are of the same pitch diameters and are mounted solidly on the shaft. These pinions drive two nests of gears, *D E C* and $D_1 E_1 C_1$, also *d* and d_1. *D* and *d* are both of the same pitch diameters. The cones of gears are mounted in two disks, *G* and G_1, which are free to rotate on shaft *A*. The gears mesh respectively with the internal gears $H\ H_1\ H_2$. These internal gears have extended hubs on which are the drums $I\ I_1\ I_2$. Rotary motion communicated by shaft *A* to the two cones of gears causes them to rotate at a slower rate and gives them epicyclic motion traveling around with the frames or disks *G* and G_1. If there were only one pinion meshing with an internal gear constructed in this manner no motion would be communicated to the internal gear, but since there are three internal gears meshing with pinions of different diameters it follows that there must be a relative movement between them. This fact is the basis of the claim of the invention. In order to make the apparatus convey power it is necessary to restrain one of the internal gears and this is done by applying one of the brake bands $Z\ Z_1\ Z_2$ to the drums $I\ I_1\ I_2$ respectively. If brake *Z* be tightened on the drum sufficiently to hold it, the gears *D* will travel around within the fixed internal gear *H* and motion will be communicated to internal gears $H\ H_1\ H_2$ and in a direction opposite to the direction of motion of shaft *A*. If the brake Z_1 be applied the gear *H* will then run in the same direction as the shaft while the gear H_2 will move in the opposite direction but at a further reduced speed; and if brake Z_2 be applied then both gears *H* and H_1 will move in the same direction of the shaft *A* but at different speeds. The relative position of the drums $I\ I_1\ I_2$ need not of course be as shown in the cut and the method of application of the brake bands need not be as illustrated but may be varied so that motion may be taken off as the application of the piece may suggest. For example, for hoisting purposes it is suggested that the drum for the lifting chain might be rigidly attached to K_1 in which position it could be made to revolve in either direction or stopped by the application of the brakes. While this device is not properly a speed varying mechanism *per se* it does have certain suggestive features inasmuch as it is possible to use a multiplicity of gears. It, however, is open to the serious fault of most epicyclic trains and that is inefficiency, caused by friction losses.

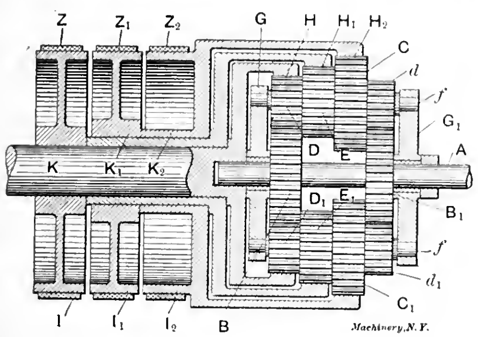


Fig. 71. Differential Device of R. H. F. and A. H. Finlay, Patent No. 642,594 February 6, 1900.

The variable speed mechanism shown in Fig. 72 was patented December 11, 1900. The patent No. 663,442 was granted to M. C. Johnson and the invention is designed more particularly for the requirements of automobiles and for this reason contains a reversible feature which is not a necessary function of all variable speed devices and, therefore, need not be considered in this connection. Three gears *J*, *K* and *L* are mounted on shaft *M* and meshing with them on the parallel shaft *A* are the gears *C*, *D* and *E*. These latter gears are controlled by clutches *F* and *G* by which any one of the three may be made fast to *A* and to revolve with it, thereby giving three distinct speed changes. The means by which the changes are effected by the simple movement of a hand lever is illustrated in the elevation cut, cams being mounted on shaft *S* which operate the levers *P* and P_1. The cams are so pitched that the speeds follow in progression and there can be no locking of gears since it is necessary to free one gear before the next gear can be engaged.

The variable speed gearing shown in Fig. 73 was patented by L. Jones, Jr., April 23, 1901, patent No. 672,779. It is of the type used on automobiles having two or more speed changes which are effected by tightening and loosening brake bands encircling drums. These brake drums are indicated at $A_1\ B_1\ C_1$. The drum A_1 is solidly mounted on shaft *A*. Adjacent to it is a clutch collar controlled by lever *P*. The shape of this clutch collar is such that the clutches controlled by arms C_2 are successively applied as the clutch collar is moved to the right. Loosely mounted on shaft *A* are three gears *B*, *C* and *D*. Meshing with these gears are the two sets of gears, *H*, *G* and *I*. These latter are mounted in the frame *F*, which is integral with drum A_1. The shaft *A* rotates continuously at uniform speed in the direction of the arrow shown thereon, and when the gear *B* is secured to the shaft *A* it drives the gear *G* in a direction, of course, opposed to the arrow. Said gear *G* is annular, and its inner circumference is opposed to friction-pawls at *e*, which are mounted for oscillation in the hub *E* of the spindle and pressed into engagement with said gear *G* by springs. Rotation of the spindles in this direction tends to progress them and the drum *F* in the same direction, and to prevent such progression, pawls are provided on the side of the drums which engage in the stationary ratchet *L*. Therefore, when the gear *B* is secured to the shaft *A* as the driving medium, the spindles being prevented from progression, the sleeve D_1 is rotated, in the direction of the arrow marked thereon, at a rate of speed which is much slower than that of the shaft *A* and determined by the ratio of the engaged gears

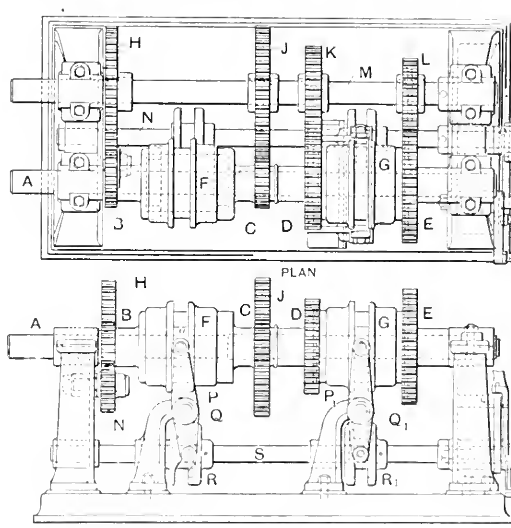


Fig. 72. Patent No. 663,442, granted to M. C. Johnson, December 11, 1900

B G and *I D*. During the rotation of the sleeve at the slow speed the planetary gears *H J* respectively rotate the gears *C* and *K* idly in the same direction as said shaft and sleeve. When it is desired to rotate said sleeve at the medium speed, the gear *C* is secured to the shaft *A* as the driving medium, and the planetary-gear spindles *E* are rotated more rapidly by reason of the difference in ratio between the engaged gears *C H* and now idle gears *B G*, so that the hub and the pawls slip forward with respect to the gear *G* without engaging the latter, and the sleeve D_1 is rotated by the engaged gears *I* and *D*. During the operation of the device at medium speed the brake-drum *K* is idly rotated. When it is desired to drive the sleeve *D* at the highest speed, the drum *F* is secured in fixed relation to shaft *A* as the driving medium and the sleeve D_1,

being held by the fixed relation with the shaft, rotates at the same speed as the latter. Except when locked as just described, the drum F has a tendency to rotate backward and is only prevented from thus rotating by the engagement of the pawls in the stationary ratchet L. Therefore, if the drum F is freed from the ratchet L, and the brake-drum K, which normally rotates idly in the direction of rotation of the shaft A, is prevented from rotating, the progression of the planetary gears J around the gear k of said brake reverses the drum F at a speed greater than the speed of rotation of the sleeve D_1 in which the result that the direction of rotation of the sleeve D_1 is reversed with respect to the direction of rotation of the shaft A.

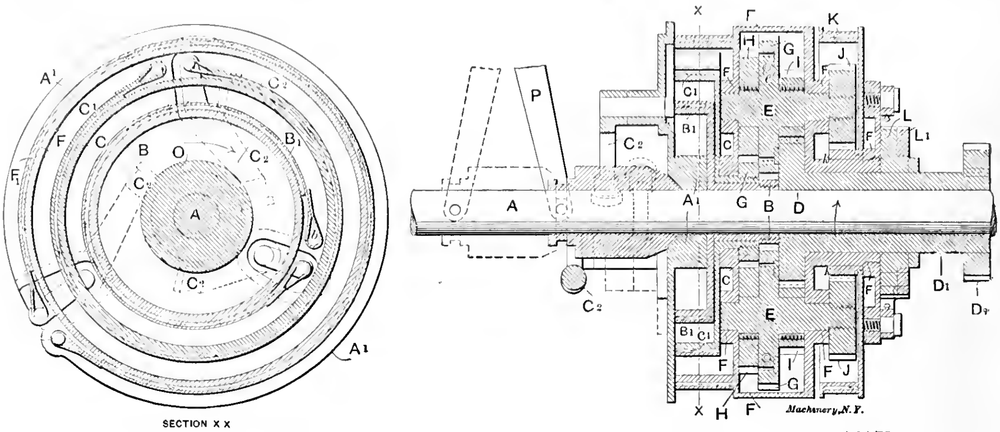


Fig. 73. Variable Speed and Reversing Mechanism. Patented by L. Jones, Jr., April 23, 1901, No. 672,779.

The changeable speed gearing shown in Fig. 74 was patented by John E. Sweet, September 10, 1901, patent No. 682,507. It is of the type having two cones of gears, one of which cones is provided with a sliding key by which each individual gear of the cone may be successively made fast to the driving shaft. In this invention the keys are made in duplicate, being indicated at $P P'$. They are pivotally mounted and wards are provided between adjacent gears so that when moved from engagement with one gear to engage the next the keys move radially inward out of engagement with the first gear and then spring into place to the keyways of the adjacent gear. The wards referred to are washers indicated by w and the operating handle is shown at E. By this construction the keys or splines must be entirely out of engagement with one gear before they are engaged with another. Moreover the operation of changing from one speed to another while in motion is facilitated inasmuch as the pressure required to disengage the keys radially with the construction indicated in the cut must

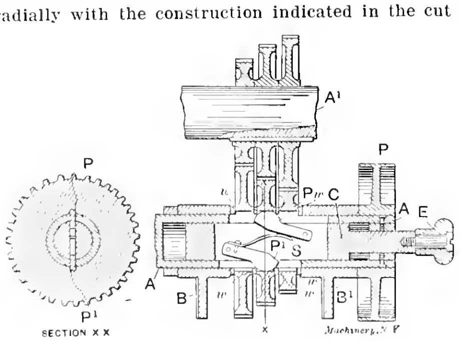


Fig. 74. Patent No. 682,507, granted to John E. Sweet, Sept. 10, 1901

be somewhat less than is required when they are moved longitudinally as in the usual construction of this type. The double key or spline is simply for the purpose of giving greater strength and to balance the thrust of the gear against the shaft, thus making changes from one speed to another still easier than is possible with only one.

Fig. 75 shows the change speed gear patented by A. Soames and W. Landon-Davies, November 22, 1904, patent No. 775,508. This invention is of the type having two parallel shafts on which are mounted gears of varying dimensions so arranged that only one pair of gears can be in mesh at the same time. Engagement with other pairs is effected by shifting one shaft longitudinally with respect to the other. In the drawing of the motor the continuous shaft is shown at A, being connected to the flywheel by clutch C. The driven shaft is shown at B and on it are mounted the gears I, J and K. Matching with these gears are gears E, F and G mounted on the sleeve H. This device, which is intended for changing the speed on automobiles, is so constructed that the mechanism must be disengaged from the source of power before change of speed can be effected. The foot lever T must be depressed to disengage the clutch C before the latch Q can be raised. This motion also disengages the square jaw clutch N at the same time. Then the sleeve carrying gears I, J and K may be moved longitudinally so as to engage other pairs of gears to effect the desired speed change. The reason for using the positive

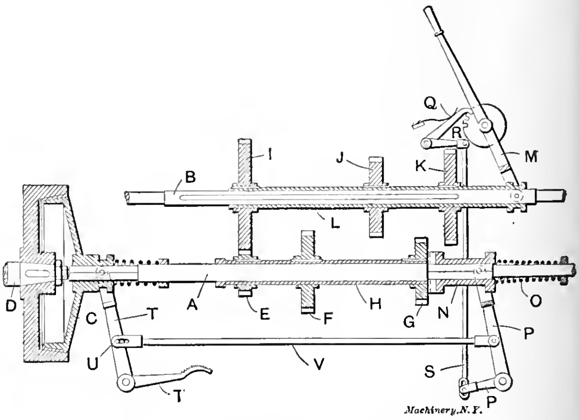


Fig. 75. Patented by A. Soames and W. Langdon-Davies, November 22, 1904, Patent No. 776,508.

clutch N is that by its use the friction clutch may be entirely disengaged from the sleeve H carrying the change gears and thus the inertia reduced to a low amount when engaging a fresh pair of gears. After the gears are engaged the positive clutch makes the sleeve fast to the shaft A and then further movement of the foot lever T throws the friction clutch into engagement with the engine. It is of course apparent that the weight and the diameter of the positive clutch may be made much less than that of the friction clutch which is a very important consideration with speeds of six or eight hundred revolutions per minute.

* * *

One of the interesting exhibits of the Watervliet Arsenal is a full-size wooden model of the huge 16-inch gun, model 1895, which was built for the defense of New York Harbor. This great gun, which bids fair to be the only one of its kind ever to be constructed in this country, has not as yet been mounted, although it is eleven years since its construction was started.

COMPLETE SCHEME FOR TURRET LATHE FIXTURE WITH SPECIAL SET OF TOOLS.

C. V. RAPER.

The samples *A*, *C*, *D* and *F*, to be machined, had to be interchangeable and made to gages of .001 inch limits. Fig. 1 shows the four samples of finished work, the rough castings *C* and *D* having parallel portions cast, as shown by the dotted lines marked "parallel." This was to save a set of special jaws for the Whiton chuck. The following "operation and tool list" explains the method of tackling each part and may serve as an example of how such special tools are gone into. Such a list is sent to the customer by the firm who supplies the turret lathes on receipt of an inquiry, together with blue print of samples. The customer's works manager or department head then goes through the list and strikes out any tool he considers unnecessary. There are always a few of them wedged in, so a careful examination usually repays itself, but the inquiry should be conducted by a capable man, understanding the system.

The tools in the list following, which have a "star" attached, were considered to rank among the superfluous lot by a certain draftsman who had the overseeing of the job, and it would be interesting to hear what other readers think of his "weeding." Did he take out too many or too few?

Anyway, presuming that the selection of tools has been performed and the order placed, the next thing the customer does is to send, say, one dozen or so of rough castings of each of the pieces under consideration, and either he or his representative journeys forth (on receipt of communication) to see that the estimate time limits are bona fide.

Usually the time is quite a lot under that first stated, often as much as 20 per cent, and sometimes it is the other way.

Again, when a man in the "home" shop gets fairly used to the job, there can be a further per cent deducted till you get your premium price data fixed for that job.

Referring to the illustration showing the cutters, it will be seen that "A. W." steel and the Magic brand are both employed for some of the cutters. Comment on the advisability of special steels for certain classes of cutter would be valuable. "A. W." steel seems to top the list for lathe "bar tools" roughing, in a recently published tabulation of Dr. Nicholson's Manchester tests. Anent this, I notice that Messrs. Vickers, Sons & Maxim "withdrew" from the contest very early in the game. Why was this, I wonder? Is it possible that the "show" was not run quite fairly?

However, it is not very wonderful that the manufacturers of "A. W." steel should come out on top with a lathe of their own supplying, worked by (or at least "watched over" by) one of their own operators, while the other brands of steel stood absolutely on their merits. I am off the track now, but while getting back I'd just like to say that I hold no brief for, nor shares in, any concern making high-speed steel.

The operation and tool list for the before-mentioned samples is as follows:

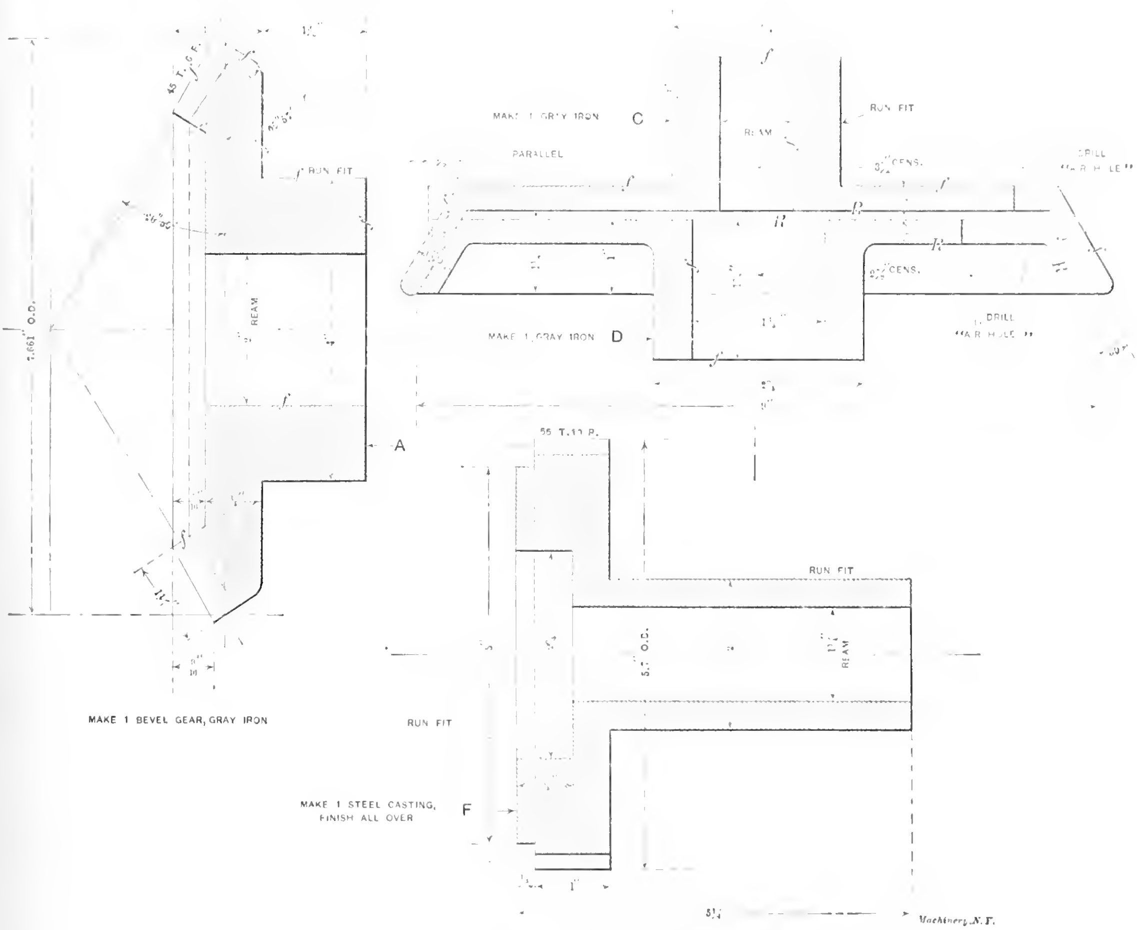


Fig. 1. Four Samples of Finished Work for which the Tools are Illustrated and the Operations Listed in this Article

SAMPLE A.—Make from Iron Castings.

Hold by taper portion in special jaws in three-jaw chuck.

Rough bore with boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

*Finish ditto.

Bore to size with single-point boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

Ream with adjustable reamer held in floating holder bolted to face of turret.

Support on revolving steady peg held in holder bolted to face of turret.

Rough turn and face boss and flange with tool held in square turret.

Finish ditto.

After a quantity have been finished in the above manner, turn end for end.

Hold by flange in soft jaws in three-jaw chuck.

Rough face flange, and rough face end of boss with tool held in square turret.

One bush for revolving steady peg.

One set of soft jaws for three-jaw chuck.

*One radius form tool.

SAMPLES C AND D.

These were handled as follows:

Make from iron castings with a short portion of the outside diameter cast parallel to facilitate chucking.

Hold by parallel portion in three-jaw chuck.

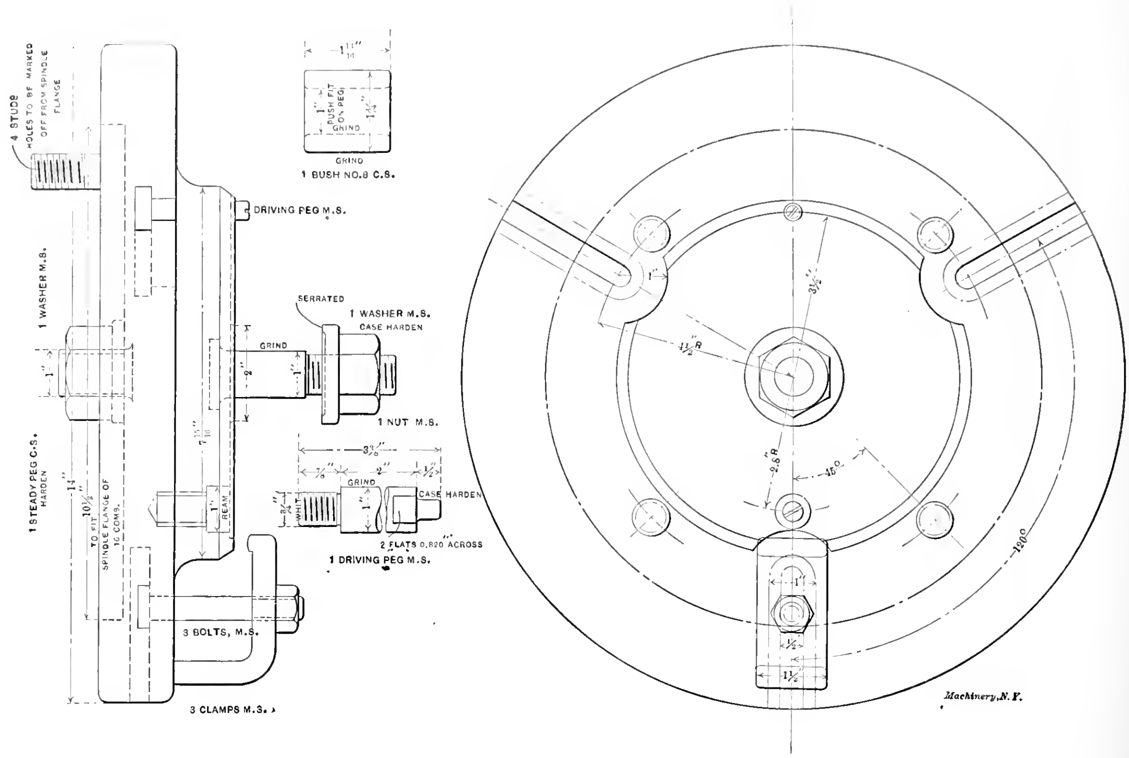
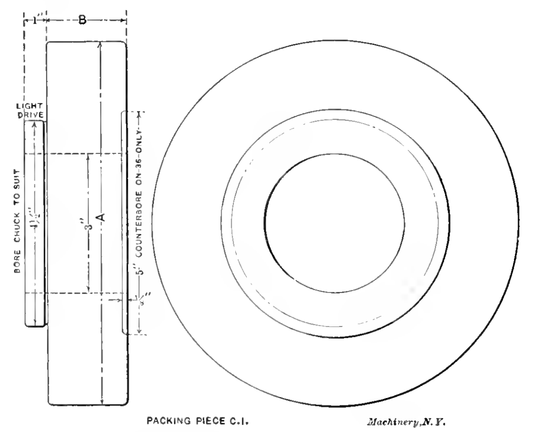


Fig. 2. Special Chuck used in Machining Operations.

Finish ditto.

*Form radius on end of boss with tool held in square turret.

Guaranteed time each, 1¾ hour.



	A	B
ONE	8½"	1¾"
ONE	5"	1¼"

Fig. 3. Packing Piece used in Connection with Chuck.

Tools Required.

One set of special jaws for three-jaw chuck.

One cutter for rough boring bar.

*One cutter for finish boring bar.

One adjustable reamer.

Rough bore with tool held in holder bolted to face of turret.

Finish ditto.

Ream with adjustable reamer held in floating holder bolted to face of turret.

Rough bore taper and rough face web with tools held in square turret.

Finish face web with tool held in square turret.

Finish bore taper and face end with combination boring, turning, and facing tool bolted to face of turret, and supported in steady bush fitted to chuck.

After a quantity have been finished in the above manner, we recommend that two air holes be drilled, which would allow the air to escape when the clutch is forced into position. They would also be used for clamping the sample against the fixture, after which the operations would proceed as follows:

Hold on special plate fixture, locating the finished hole of sample on a hardened steel peg, and clamping by the boss, a peg being fitted into the fixture opposite one of the air holes to act as a driver.

Rough turn taper portion on outside, rough face web, and rough turn boss with tool held in square turret.

Finish ditto.

*Form taper portion on outside with tool held in square turret.

Remove clamp from boss, and clamp through the air holes.

Rough and finish face end of boss with tools held in square turret.

Guaranteed time of each: Sample *C*, 1¾ hour; sample *D*, 1¼ hour.

Tools Required.

Two rough boring tools.

Two finish boring tools.

One adjustable reamer and floating holder.
*One extra adjustable reamer.
One rough boring tool for square turret.
One rough turning and facing tool.
One finish ditto.
One combination boring, turning and facing tool, fitted with a steady peg and set of cutters.
One steady bush fitted to chuck.

turret, and supported in steady bush fitted to chuck, and at the same time rough turn and face short boss and rough turn large diameter with tool held in square turret.

*Finish bore with boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

Bore to size with single-point boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

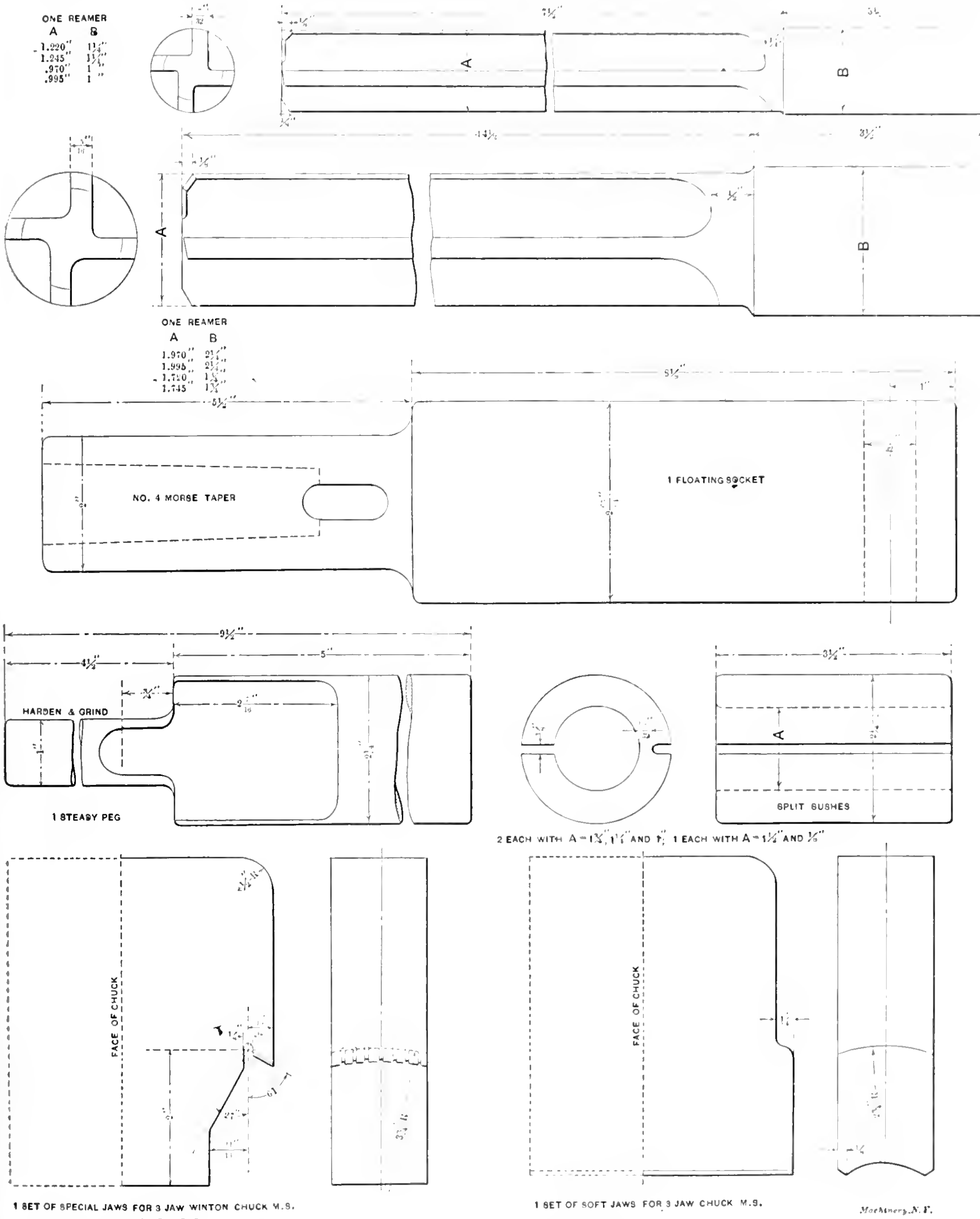


Fig. 4. Reamers, Collets, Chuck Jaws, Etc.

One special plate fixture, with two sets of clamp plates.
*One extra steady peg for same.
One steady bush fitted to chuck.
*One form tool.
Two boring bar holders.

SAMPLE F.—Make from Steel Castings.

Hold by long boss in three-jaw chuck.

Rough bore with boring bar held in holder bolted to face of turret.

Ream with adjustable reamer held in floating holder bolted to face of turret.

Support on revolving steady peg held in holder bolted to face of turret.

Finish turn and face short boss and finish turn over top of large diameter with tool held in square turret.

After a quantity have been finished in the above manner, turn end for end.

Hold by short boss in soft jaws in three-jaw chuck.

Support on revolving steady peg held in holder bolted to face of turret.

Rough turn and face long boss with tool held in square turret.

Finish ditto.

Guaranteed time each, 2¼ hours.

One steady bush fitted to chuck.
One revolving steady peg.
One rough turning and facing tool.
One finish ditto.
One set of soft jaws for three-jaw chuck.
*Two boring bar holders. (One only.)

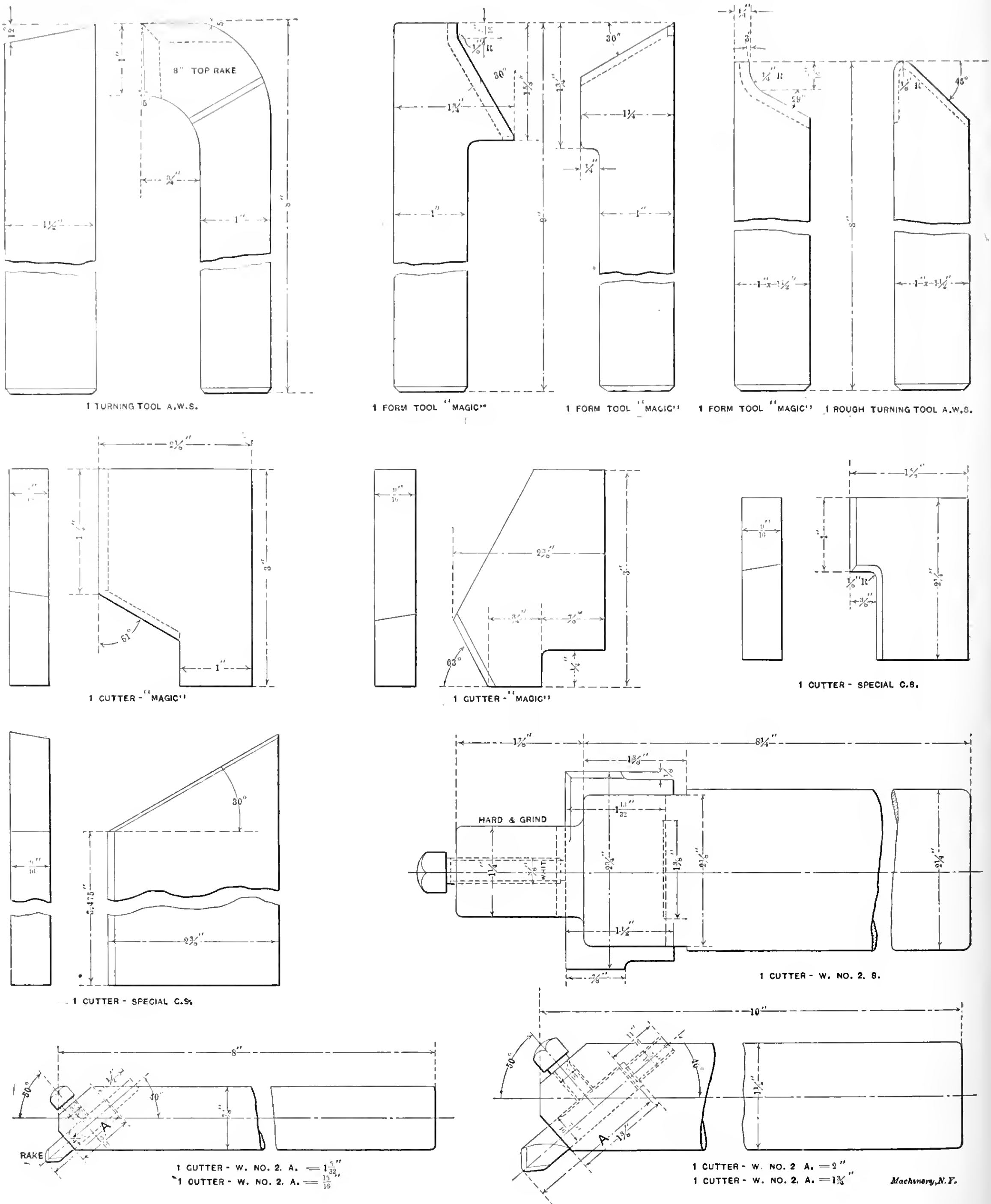


Fig. 5. Group of Cutters and Tools.

Tools Required.

One rough boring bar and cutter.
*One finish boring bar and cutter.
One single-point boring bar and cutter.
One adjustable reamer.

I might say here that the "air holes" referred to were spoken of as it was thought that the two pieces *C* and *D* were a disengaging clutch. However, the pieces eventually had oil holes drilled in them, so that this became unnecessary. It would be, of course, natural for some people to mistake this

type of non-positive feed drive for a (badly-designed) clutch. The fixture for holding both samples C and D is shown complete in Fig. 2 and is perfectly self-explanatory.

Lastly, will some readers give their opinions, as to what the cost of this outfit should have been? Perhaps it will surprise some when I say that it footed up to nearly £90 ($150) on the invoice.

* * *

WINDING OF DIRECT-CURRENT ARMATURES.*

A detailed description, given by an actual workman, of the various operations performed by an armature winder, accompanied by precise directions and data is not without unusual interest. The types of armatures to which this description apply are those used in direct-current railway motors, crane and hoisting motors, vehicle motors, bipolar motors and belted generators up to 100-kilowatt capacity.

Tools.

The tools used by an armature winder are as follows:

- 1 shoe knife,
- 1 pair seven-inch shears,
- 1 pair eight-inch pliers,
- 1 ten-inch screw-driver,
- 1 three-pound rawhide mallet,
- 1 small steel riveting hammer,
- 1 wedging tool (See Fig. 1),
- 1 heavy steel drift (See Fig. 2);
- Also an assortment of fiber drifts of varying width, length and thickness (See Fig. 3).

The rawhide mallet is used in driving the coils into the slots by means of the fiber drifts, and in bending the coils into shape. The steel hammer is used for straightening lamina-

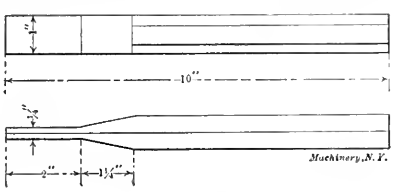


Fig. 1. Wedging Tool.

tions or finger plates. It should never be used in bending coils or on any of the drifts. The wedging tool made from a cold chisel, is used in driving wedges into the slots as a hammer would injure the insulation of the coils and might bend the laminations.

Core.—An armature core is built up of soft sheet steel laminations. These are stamped of the desired shape and carefully annealed. The stampings are then built up, and keyed to a shaft or spider and held securely in place by end plates. Ventilating spaces are left next the shaft or spider and air ducts are distributed at intervals through the punchings by putting in spreaders to hold the laminations apart. The armature in rotating draws in air through the ventilating spaces next the shaft and forces it out through the ducts, thus fur-

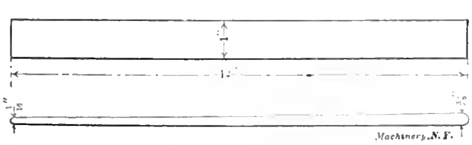


Fig. 2. Steel Drift.

nishing a simple and effective means of ventilation. After the core is assembled, the slots are filed to remove any projecting burrs—if these were not removed the insulation of the coil might be torn when a coil is driven into the slot and cause grounds and short circuits in the winding.

Operations Before Placing Coils on the Core.—The core is mounted in a winding lathe, as shown in Fig. 4. If duck blankets are used they should be placed on the shaft before the core is placed in the winding lathe. If a block is used on the rear end of the armature core to shape the coils as they are wound or to protect the cast iron end-bell, the block should be placed on the shaft before mounting in the lathe so that it will not be necessary to remove the core after it is partly wound. The core should be placed in the lathe with the commutator end at the winder's left. The commutator end of an armature may be distinguished by the key-way cut in the shaft next to the core for the commutator key; also on railway armatures the shaft opposite the commutator end is beveled and threaded to fit the pinion as in Fig. 5.

A description of the winding of a No. 38 B railway motor will be given in detail:

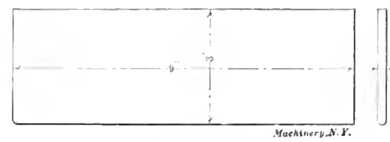


Fig. 3. Fiber Drift.

The core of this armature is built on the shaft and has three ventilating ducts parallel to the shaft. There are 45 slots. These slots are relatively narrow as compared with the width of the teeth. It will be seen from Fig. 6 that the end plate of the commutator end fits against a shoulder turned on the shaft. The rear end plate is held in position by a nut which is screwed on to the shaft and held in place by a setscrew.

Two duck blankets are used on this armature. They should be placed on the shaft with the wider side of the blanket out and with the seam toward the core. The core should be inspected to see whether any of the laminations or fingers project into the slots. The steel drift and rawhide mallet are used to clear the slot of any of these projections.

Cells.—In each slot are placed cells of paraffined express paper. They are made of a width such that when folded and placed in the slots the edges will project above the core, and thus protect the coils as they are placed in the slots. The cells are stiff enough so that when bent into the slots they are not easily shaken out, as the armature is revolved in winding. If any cells are longer than the slots they should be cut off so that both ends of the cells will be flush with the ends of the slots.

Coils.—In winding this armature, 45 complete coils are used. Each coil, *i. e.*, complete coil (See Fig. 7), is made by assembling in a cell three individual coils each consisting of two

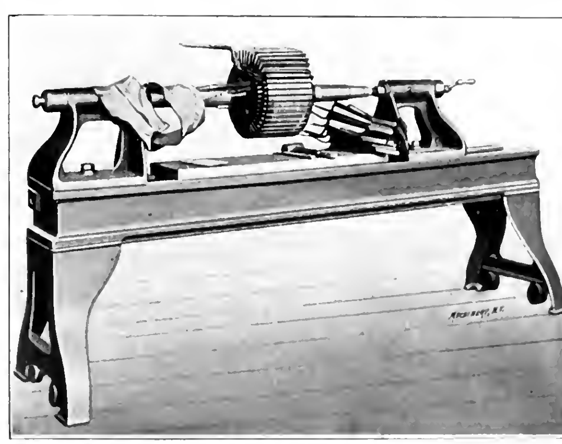


Fig. 4. Winding Lathe.

turns of No. 9, double cotton covered wire. Each slot contains one side of each of two different coils. One side of a coil is put in the bottom of one slot and the other side in the top of another slot. Three wires or leads are brought out from each side of the coil on the under side. This type of coil is known as a "three-lead coil."

Taping.—The middle lead of the three coming from the bottom side of the coil is taped with black tape, the outside lead is taped with white tape and then all three leads are taped together. The top leads are not taped but are bent up and outward, as shown in Fig. 8.

Putting Coils in the Slots.—Beginning with any slot the

* A. C. Jordan in the *Electric Journal*, December, 1905.

bottom of a coil is placed in it so that each end of the coil is at an equal distance from the core, the top of the coil resting on the core. The bottom of the coil is forced to the bottom of the slot by means of the fiber drift and mallet. Call this slot No. 1, and count toward the top of the coil until slot No. 11 is reached. Start the top of the coil in this slot. This is called a throw of 1 and 11, or simply 11. The tops of the first ten coils are not forced into the slots as they must be taken out when the last ten coils are put in place (See Fig. 8). The bottom of the next coil is placed in slot No. 45, and the top in No. 10. After the first eleven coils are in place the tops should also be driven into the slots. Continue in this manner around the armature until slot No. 11 is reached. Beginning with slot No. 45, take out the tops of all the coils up to and including the one in No. 11 slot and bend them away from the armatnre so that the bottom sides of the last ten coils can be placed in the slots. After the last ten coils have been placed in position, the tops of the coils which were removed to make place for the last ten coils are put in place.

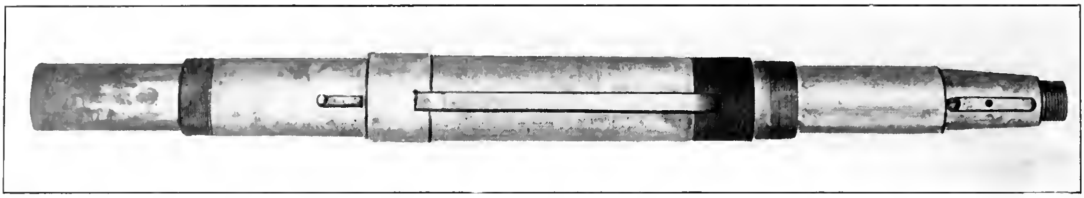


Fig. 5. Armature Shaft.

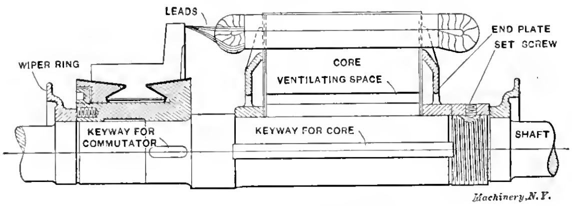


Fig. 6. Section through Armature.

A piece of heavy wire is wrapped around the coils at each end just outside the core and tightened with the pliers as firmly as possible. This is to hold the coils in the slots while the winding is being tested, trued and connected. If the upper leads are not bare at the outer ends, the insulation should be scraped from them for about three inches. All the npper leads are then connected by a fine copper wire. Care must be taken that no leads touch the core or shaft as the leads are not required to be insulated sufficiently to withstand the voltage used in the insulation test. This test consists in applying 3,600 volts between the winding and the core. If the test shows a ground in any coil, the coil is removed and a new one substituted.

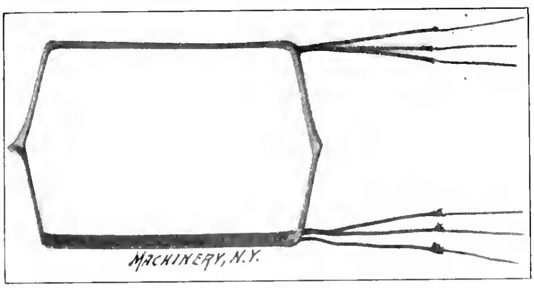


Fig. 7. Armature Coil.

After the armature has passed the insulation test, the tops of the slot cells are cut off even with the core. Then the tops and ends of the coils are trued. To do this the armature is revolved in the lathe and a piece of chalk is held so that in turning the armature it will mark the coils that project. These are then driven down, or the others are brought out even with the high ones. The fronts of the coils are then trued. In Fig. 9 parts of the winding being trued are marked with white chalk.

The blankets are next fitted over the front ends and sewed on with a curved needle and wax thread. The thread is passed in under the ends of the coils and brought up through them near the core and tied firmly over the blankets. They should be tied in at least six different places. The blankets are to separate and insulate the leads from the ends of the coils after the leads are connected to the commutator (See Fig. 10).

The winder then stands on the opposite side of the lathe and takes the bottom lead of any coil and counts seven slots in a clockwise direction facing the commutator. This lead is bent up and across the ends of the coils and held in place by the lead from tthe seventh slot. Proceeding in the same manner around the armature in a counter-clockwise direction facing the commutator, all of the lower leads are bent like the first one and secured by the upper leads. This finishes the operation of winding. The armature is now ready to have a commutator pressed on.

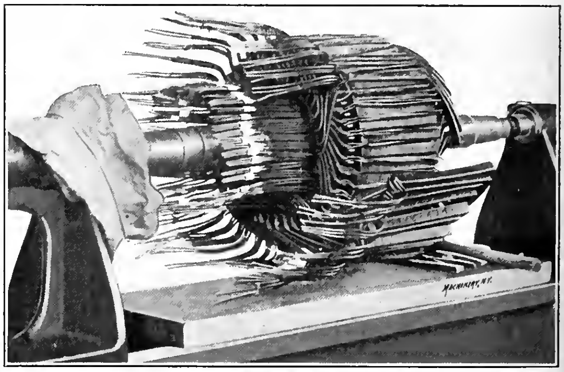


Fig. 8. Inserting the Coils.

Pressing on Commutators.—Small commutators are pressed on to the shaft by a hand press. All of the larger commutators are pressed on by means of a power press. In Fig. 11 is shown a hand press. The plate *B* is used in removing old commutators. It is placed back of the commutator as at *x y* with the slot *C* over the shaft. Bolts *a b* are passed through the holes *a a* in the plate and secured by nuts. The commutator, can then be forced off the shaft. In pressing on a commutator, a sleeve is placed over the shaft at *O*, and rests

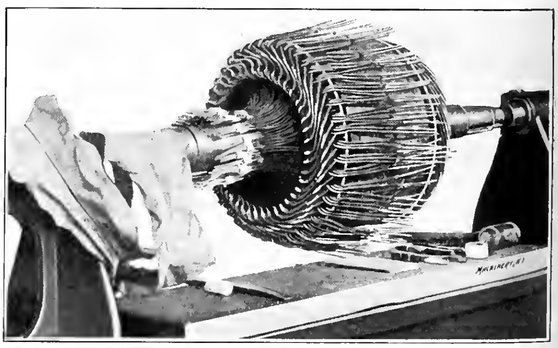


Fig. 9. Truing-up the Winding.

against the commutator. The rear end of the shaft is secured so it will withstand the pressure, and the commutator is forced on. The power presses are built on the principle of a hydraulic press. In pressing on a commutator a piece of babbitt metal or soft brass should be used against the end of the shaft. The shaft should be painted with white lead before having the commutator pressed on, in order to lubricate the shaft so that the commutator will press on easily. The wiper rings are pressed on after the commutator and then the armature is ready to be connected.

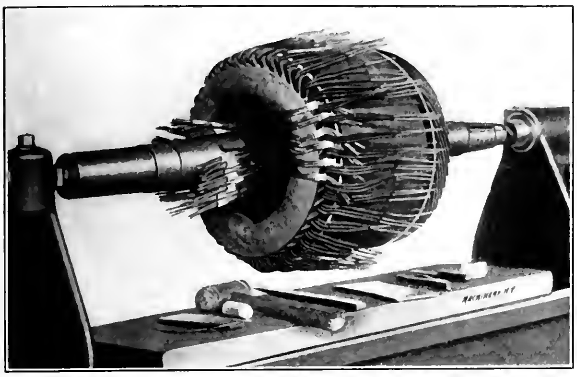


Fig. 10. Fitting the Canvas Blanket.

Connecting.—The first operation necessary in connecting is to "lay-off" the commutator. In "laying-off" the upper and lower leads of any coil are found by means of a lighting-out set. The slots which contain this coil are marked with chalk. In connecting a No. 38 B railway motor armature the following should be noted: There are 135 bars in the commutator. The throw of coil is 1 and 11 and, as the winding is progressive the commutation throw equals

$$\left(\frac{\text{number of bars} + 3}{2} = 69\right) \text{ is 1 and 69}$$

With this commutator throw the center of the throw will be a bar. The throw of a coil is 1 and 11, therefore, the center of

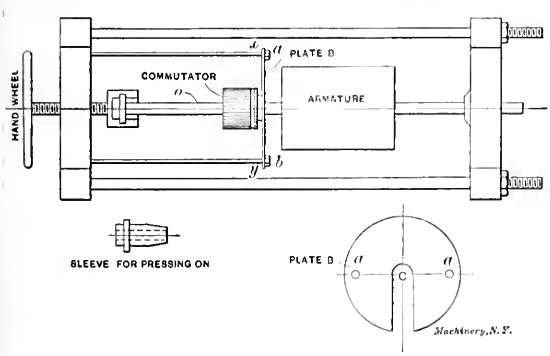


Fig. 11. Press for Forcing on and Removing Commutator.

a coil throw will be a slot. Hence every slot should line up with a bar. By holding a pencil on the commutator perpendicular to it and sighting along the side of a coil the bar opposite the center of the slot in which the side lies may be located as at *A* in Fig. 12. Mark this bar with a colored pencil. Find the bar opposite the other side of the coil, as at *B*, and mark with the pencil, calling the slot in line with *A*, No. 1. Count 20 bars from *A*, in a clockwise direction and mark this bar No. 1. Also count 20 bars from *B* in a counter clockwise direction and mark this bar No. 69. Count from this bar to and including bar No. 1 and there should be 69 bars. Also there should be 29 bars between *A* and *B*. *D B A C* is called the forward throw and *D C* is the back throw. It is seen that the back throw is 66 or three less than the forward, as it always will be in a four-pole, progressive wave-wound armature. If an armature is wound retrogressively the forward and back throws differ by one. If, in laying-off, the center of the slot does not come in line with a bar, find one that will line up with a bar and proceed as above.

The 38B armature has three leads on each side of a coil and as there are 135 bars, there is no idle coil in this winding. Place the middle lead of the three coming from the bottom of slot No. 1 in bar No. 1, the outside lead in bar No. 135 and the inside lead in bar No. 2. Next take the lower leads from slot No. 2 and place them in bars No. 3, 4, and 5. The insulation should be removed from the leads where they are to be soldered to the commutator necks. They are driven to the bottom of the slot by means of a tool similar to the wedging tool only much thinner. The lower leads are all placed in the commutator and then they are "lighted-out."

Lighting-Out.—The purpose of lighting-out is to see that there are no grounds or short circuits between the bars or coils, and to see if the leads are connected to the proper bars.

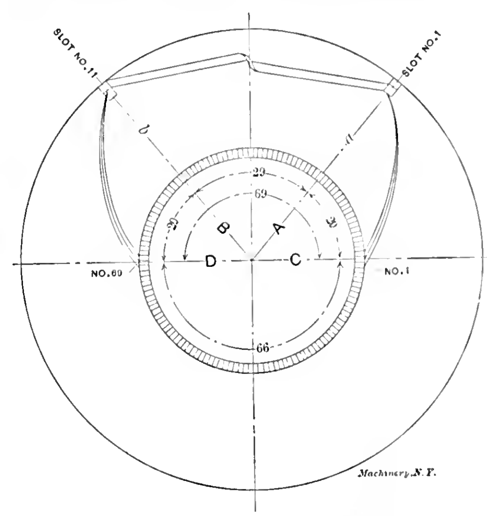


Fig. 12. Armature Connection Diagram.

The lighting-out set consists of two terminals connected in series with a 110-volt incandescent lamp to the 110-volt service lines.

One terminal of the lighting-out set is placed on bar No. 1 and the other on the middle lead coming from the top of same coil. The lamp should light. Next move the terminal on commutator bar No. 1 to bar No. 2 and if the lamp lights it shows a short-circuit between bars or between coils. If the lamp does not light the upper terminal is moved to the next lead counter-clockwise, when the lamp should light; if not, find the bar on which it will light and bring the wire connected to that bar to the proper bar. Continue in this manner around the commutator. After the winding is lighted-out, the ends of the leads projecting out over the commutator beyond the neck are cut off and saved as they are to be used again.

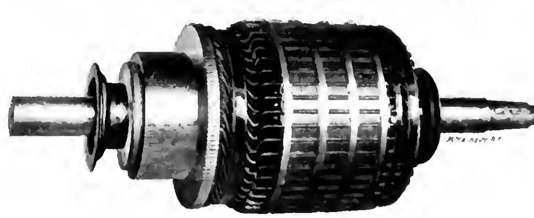


Fig. 13. The Completed Armature.

Two layers of friction cloth are then wound over the lower leads and then the upper leads may be connected. The center lead from slot 11 is connected to bar No. 69, the outside lead is connected to bar 70, the inside lead from slot No. 12 is connected to bar No. 71, and so on around the armature. After the leads are all placed in the slots in the commutator necks, they are driven to the bottom of the slots. The lower leads which were cut off are known as "dummies." These are driven into the tops of the slots until the slots are full. After putting in the dummies, all projecting ends are cut off and the

armature is tested for grounds and short circuits. The leads are then soldered in the slots and the armature is then ready for banding.

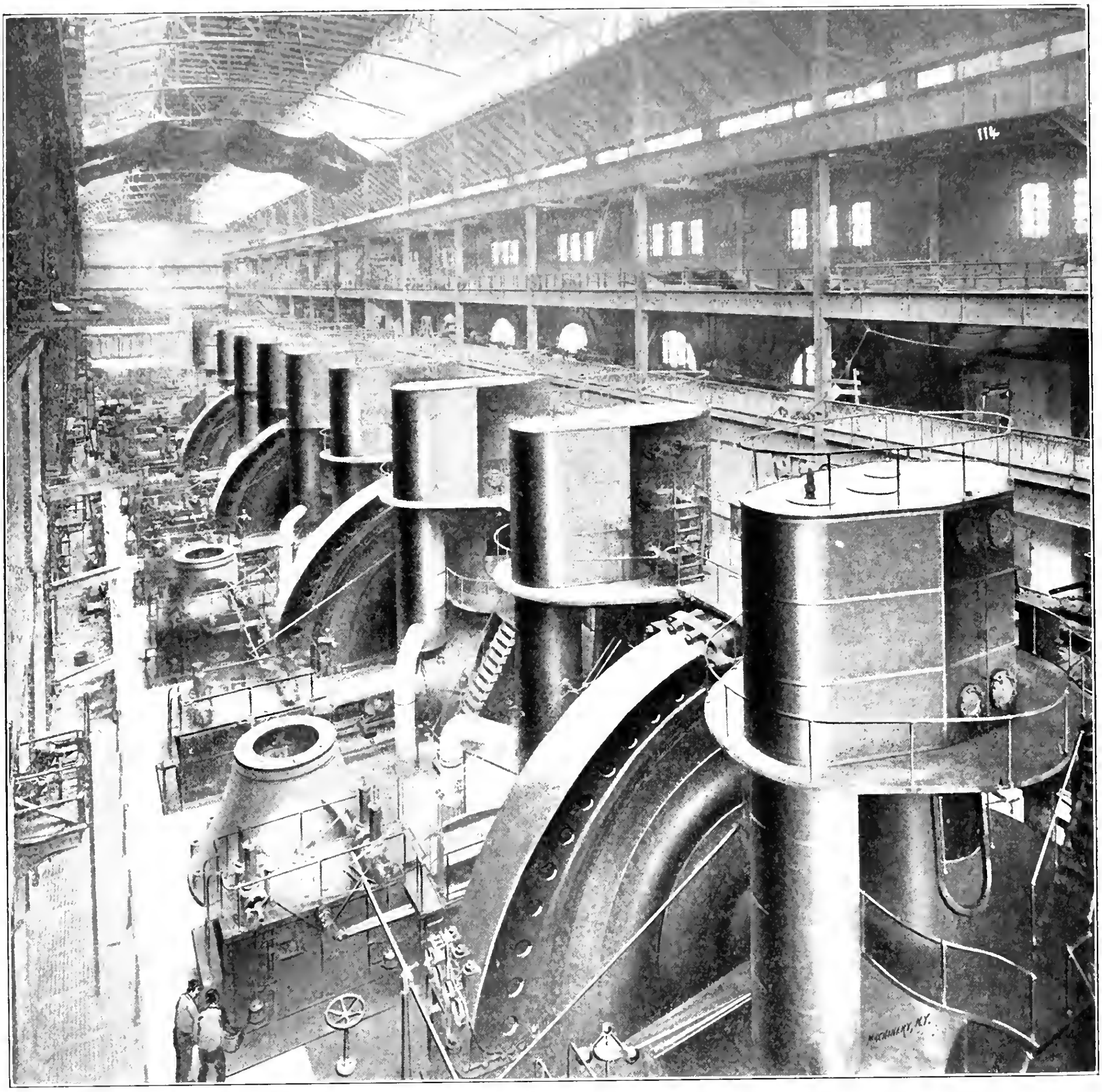
Banding.—Tinned steel wire is used in banding. The bands on the core are insulated with mica and fullerboard while on the coils they are insulated with Japanese paper and tape. The insulation is made wide enough so that it projects one-eighth of an inch on each side of the bands. The bands on the core and leads are five-eighths of an inch wide, while the ones on the ends of the coils are made as wide as possible. In putting on the bands the armature is rotated in a lathe and the steel wire is wound on under tension. Clips are placed under the band wires and after sufficient turns have been wound on, the clips are bent over the wires and soldered to them, so that the band wires are held firmly together. After the bands are all on, they are heated with a soldering iron and solder run around each band. Thus the wire and clips are all held firmly in place.

Seven strips or bands are placed on the armature, four on the core, one on each end of the coils and one to hold the leads in place. These are shown in Fig. 13. The two bands on the rear end of the coils are connected to the last band on the core by means of three anchor clips spaced equally around the armature. This is done so there will be no danger of the outer bands slipping. After the armature is banded it is tested for short-circuits or grounds, given a coat of insulating paint and is then ready for assembling with the other motor parts.

* * *

INTERBOROUGH RAPID TRANSIT CO. TEST OF SUBWAY ENGINES.

An interesting official fifteen-hour test of one of the nine twin vertical-horizontal Reynolds Corliss engines, cylinders 42 inches and 86 inches by 60 inches, which have been in operation at the 59th Street station of the Interborough Rapid Transit Co., New York City, since 1902, was concluded December 15.



The Engine Room of the Fifty-ninth Street Station of the Interborough Rapid Transit Co.

The tests were conducted by the Interborough Rapid Transit Co. and representatives of the Allis-Chalmers Co. as a final determination of the fulfillment of the builder's guarantee and formally provided for in the original contracts.

How well the tests of engine No. 8, which was selected as representing all the engines installed, fulfilled the claims made for it, may be readily ascertained from the following data, giving a synopsis of the completed tests.

As per agreement, on account of the impossibility of keeping a constant load, the power was determined by the readings of tested integrating wattmeters. These readings were reduced to I. H. P. by running the generator as a synchronous motor;

adding the electrical input to the switchboard readings when developing power, to obtain the power exerted by the engine.

The result of the test so made, under conditions approximating the contract requirements of 7,500 horse power, 75 revolutions per minute, 175 pounds steam pressure, and 26-inch vacuum, was a consumption of 11.96 pounds of dry saturated steam per I. H. P. hour, or well within the guarantee of 12.25 pounds. The steam consumption per kilowatt hour at the switchboard was 17.34 pounds.

Duration	15 hours
Load	5,079.2 K.W.
Friction and generator losses	417.3 K.W. = 559.41 H.P.
Total load	5,496.5 K.W.
I.H.P.	7,365.3 H.P.
R.P.M.	75.02
Steam pressure	175.18 lbs.
R.H. receiver	19.1 lbs.
L.H. receiver	19.27 lbs.
Vacuum	26.02 inches (actual)
Temperature injection water	42.36 degs.
Temperatnre R.H. discharge	74.05 degs.
Temperature L.H. discharge	77.38 degs.
Barometer	30.50 inches
Water per hour	89,906 lbs.
Drips per hour	512 lbs.
Leakage per hour (boiler)	1.470 lbs.
Boiler level correction	60 lbs.
Net water per hour	87,864 lbs.
Quality of steam	100.28 per cent
Dry steam per hour	88,110 lbs.
Dry steam per K.W.H.	17.34 lbs.
Dry steam per I.H.P.H.	11.96 lbs.

The final results allow for boiler leakage, which was determined by a separate test of twenty-four hours' duration. The steam was very slightly superheated during the test, as being easier to make allowance for than wet steam, and a correction was made to reduce the superheated steam to equivalent dry saturated steam.

The vacuum was carried at 26.02 inches, or as near the contract requirement as possible, but the barometer stood at 30.50 inches. The vacuum was, therefore, equivalent to only 25.52 inches referred to 30-inch barometer; no correction was made, however, as none was provided for in the contract. Other tests at varying vacua show that if the vacuum had been carried enough higher to correspond to 26 inches vacuum when referred to 30 inches barometer, the steam consumption would have been about 0.09 pounds better, or 11.87 pounds per I.H.P. hour, instead of the official figure of 11.96 pounds.

The tests were made under the supervision of Frank N. Waterman, who acted as referee. The following represented their several companies: Interborough Rapid Transit Co.—H. G. Scott, superintendent motive power; J. Van Vleck, mechanical engineer; H. W. Butler, principal assistant engineer; Thos. Allsop, mechanical engineer, 59th Street power station; C. W. Picker, electrical superintendent; G. F. Chellis, instrument man; W. L. Seabrooke and W. S. Finlay, assistant engineers.

Allis-Chalmers Co.—A. M. Mattice, chief engineer; Samuel Moore, district superintendent of erection; T. T. Hubbard, engineer test; J. W. Lord, sales representative; C. A. Hoppen and C. J. Larsen, construction department; A. F. Rolf and F. Buch, electrical representatives.

* * *

A new type of electric converter was exhibited at the Brussels exhibition, being what is known as the permutator. This machine, which is for the conversion of alternating current into direct current, has no revolving armature; the lines of force in the stationary winding are cut by a revolving field which is obtained by means of polyphase currents. The brushes are revolved around the commutator instead of revolving the commutator as in the synchronous converter. The advantage of the machine is that it can be brought to full speed in a few seconds, there being little inertia in the revolving brushes as compared with an armature. Again there is no air gap so that the magnetic leakage should be small. A disadvantage, though not serious, is that the brushes revolve and this complicates the matter of brush adjustment with the developed centrifugal force, which must be counteracted at the normal speed so as to give the required brush pressure.

REPRESENTATIVE AMERICAN MECHANICS.

JOHN RICHARDS.*

For the last twenty-five years, amongst technical men on the Pacific Coast and especially amongst those devoted to mechanical engineering, no name has been more widely known than that of John Richards. Young inventors have sought his help to get into trouble and old inventors have sought his help to get out of trouble. There are few problems connected with mechanical progress in whose solution Mr. Richards has not, at some time or other, taken part, while his genial disposition and rigidly upright character have always enabled him to count among his devoted friends the best men in the engineering profession, not only on the Pacific Coast, but wherever engineering is considered an honored profession.

Mr. Richards is of Scotch extraction, the son of a physician, and was born in Pennsylvania in 1834, whence the family removed to southern Ohio in 1844. Here young Richards attended public and private schools until 1848, when, at the age of fourteen, he was sent to learn millwrighting, which at that time included the erection and care of steam engines, and for some time acted as a stationary engineer. He served also for about two years as a steam-boat engineer on the western rivers. About 1854 Mr. Richards, thinking that the life of a steam-boat engineer was too contracted, left the river and began to qualify himself as a works foreman, serving terms at cabinet work, joiner work, wood construction in millwrighting, and machine fitting. In 1859, on account of some notable improvements made by him in apparatus for turning out wooden screws, grinding edge tools, etc., he was appointed a division foreman in the Ohio Tool Company's Works at Columbus, Ohio. Here he began improvements in the plant and in various processes involved in that large company's business, became general foreman and finally, in 1864, superintendent, an office Mr. Richards still holds, nominally at least, as there has never been a successor. While working himself into notice as a skilled mechanic, during the eight years he was at Columbus, he did not lose sight of other possibilities in the future, so he studied under private tutors the science of engineering and mathematics, qualifying himself for designing as well as executing.

In 1867 Mr. Richards became a charter member, director and constructing engineer of the J. A. Fay Co., of Cincinnati, Ohio, and began a remodeling of wood working and kindred machinery of various kinds. In 1869, at the suggestion of Mr. W. B. Bement and Mr. William Sellers, senior members of the two principal machine tool works in this country, Mr. Richards sold out his interests in Cincinnati, and, after a trip to Europe to examine into the state of the art in wood working

* Contributed by Geo. W. Dickie.

and other machinery there, settled in Philadelphia and founded the Atlantic Works (Richards, Thorne & Co., afterwards Richards, London & Kelley) for the construction of a superior class of wood working and other machines, especially for use in railway car building establishments. In 1873 Mr. Richards went to London and prepared there a treatise on wood cutting machines, a quarto volume containing a history and description of the methods and practice in the United States, France, and England. This work was sold at twenty-five shillings ($6.00) and has been out of print since 1880, but still remains one of the principal reference books in the wood cutter's art. This was followed by another book published in London in 1874, "The Operator's Handbook for the Instruction of Foremen and Workmen in Wood Converting Processes." This went through several editions but has long been out of print. In 1875 Mr. Richards began contributing articles to "Engineering," London, on various branches of constructive engineering work, some of which were afterwards published in book form under the title of "Workshop Manipulation." In 1877 he started the American Standard Gauge Works at Philadelphia, which is still being successfully conducted by other owners.

The partnership of the Atlantic Works expiring, Mr. Richards retired from that business and founded the firm of Richards and Atkinson at Manchester, England, makers and importers of machine tools. This business after going through some changes was absorbed in George Richards & Co., Ltd., Manchester, England, George Richards of that company being the only son of the subject of this sketch and a noted authority on machine tools in England. A branch of the English business was established at Gothenburg, Sweden, and was placed under the management of George Richards, then a student.

In 1880 Mr. Richards, considerably broken in health through over work, came to California where he met the writer and formed with him a close and lasting friendship. Here he founded the San Francisco Tool Co., at first makers of machine tools and later of hydraulic and other machinery. After conducting this business successfully for five years Mr. Richards went back to Manchester, England, to assist in organizing and expanding the company's business there, in which he was still a director, and on his return a year later, spent some months in Pittsburg with the Westinghouse Company, assisting in the development of single-acting steam engines and centrifugal pumps. On again reaching San Francisco, Mr. Richards found that the San Francisco Tool Company had taken contracts for railway building and other work not contemplated by its founder, so he refused to retain his connection with it, and, after assisting the writer with some special work in connection with the Union Iron Works, he turned over to W. T. Garratt & Co., of San Francisco, his patents, patterns, drawings, etc., and gave up direct connection with shop work, after an active and varied business experience of about thirty-five years.

Such an active mechanical engineer as Mr. Richards, could not be content, however, without having some share in the engineering activities of the Pacific Coast, so in 1888 he founded the magazine "Industry," a high class technical journal devoted to the industries of the Pacific Slope. The work accomplished by this magazine had a stimulating effect on all mechanical engineering work carried on by Pacific Coast engineers. The writer notices to-day the eight bound volumes of "Industry" occupying a prominent place in not a few of the reference libraries used in the offices of the prominent engineers here. After a successful run of eight years, "Industry" had to be abandoned for want of time and strength to prepare the subject matter for its pages, which was mostly original work for each issue.

In 1889 Mr. Richards published at Philadelphia a manual of machine construction, which contains what the writer believes to be the first attempt at tables of proportions for common machine parts. He was elected president of the Technical Society of the Pacific Coast in 1889 which office he held for three years and still, as an honorary member, contributes more or less each year to the transactions of that important organization. Mr. Richards although having earned an honorable freedom from the exacting duties of an engineering profession, has yet been unable to keep his hands and brain clear of the new problems that are ever confronting the engineer. So we find him in 1903 again taking up hydraulic work, visiting Switzerland and other parts of Europe to investigate the progress made in rotative pumping machinery, and going into harness as the president of the Turbine Pump Company of New York, which position he resigned several months ago.

Mr. Richards still attends to his consulting business in San Francisco, including the presentation and prosecution of patent cases, especially in foreign countries, and also acts as president of the North Side Water Company. He resides on a fine country place named "Ancho Vista," at San Anselmo, from whence he comes daily, about sixteen miles, to his office in San Francisco.

The class of mechanical engineering on which Mr. Richards has left his impress has been mainly that of implements and processes for manufactures in woods, metal, standard gages for accurate dimensions, steam turbines and centrifugal pumping machinery.

Mr. Richards does not like the American protective tariff system and is ever ready to protest against the artificial values it creates. He maintains that the American mechanic could hold the markets of the world if delivered from the restraints that the tariff imposes. His knowledge of foreign machine shop practice and that of this country has broadened his engineering sympathies, making him a fine specimen of a rare type, a real companionable mechanical engineer combining both the ancient and the modern. Mr. Richards has passed the three score years and ten and is yet as interested in a new problem as the most eager aspirant for engineering honors. His friends unite in wishing him many years of future usefulness.

* * *

HOW LOOSE SCALE CAUSED A BOILER BAG.

A boiler insurance company had a hurry call to examine a boiler that was reported seriously injured. One of their boiler experts was dispatched to the plant, and found that a sheet over the grate had developed a "bag" seven feet long by three feet wide, with a depth of fourteen inches, and a rupture at the deepest part. The superintendent of the plant was alarmed. He had come to the conclusion that the bag was due to original defects in the metal. As there was another boiler of the same make at the plant, he was debating whether it would not be best to throw it out, having decided to abandon the injured one, because no cause could be given for the defect save poor material. The expert proceeded with his inquiry, and found the damaged boiler had been washed out on Sunday. It was then filled up, and was being fired when the bagging took place. At that time the steam pressure was forty pounds, while when in service ninety pounds was carried. The damaged plate clearly showed the usual marks of being overheated or burned all around the bag; and, where it was not burned, the metal had stretched, indicating beyond doubt, that originally, or prior to bagging, the sheet was of excellent quality. What, then, had caused the accident? The boiler had been reported thoroughly cleaned the day of the accident, and there were no traces of oil or grease. The superintendent was insistent that his theory was correct, and claimed that the boiler when it was cleaned was free from sediment or loose scale. The expert bade him wait until the examination was over. He then entered the lower manhead, and found at the rear end of the boiler about two and one-half bushels of loose scale which he carefully brought to the front. This huge mass showed clearly that the attendant had collected the scale on the sheet over the grates, and was ready to remove it from the boiler when he was called away, and on his return had forgotten the scale and placed the man-head in position, filled up the boiler, and fired up. The mass of scale of course allowed the plate beneath it to become overheated, resulting in the huge bag or bulge in the sheet. When the bulging took place the pack of scale opened up, allowing the water to come in contact with the red hot steel. This resulted in an instantaneous generation of steam that drove the scale to the rear end of the boiler.

* * *

Right angle fillets are 93 degrees on the right angle side.

THE NEW SHOP OF THE BALL ENGINE CO.

As an example of modern shop construction, we show this month a number of half-tone views and detail drawings of the new shop of the Ball Engine Co., Erie, Pa., located in the outskirts of the city. The building is of steel frame construction, with brick walls, and it has an unusual amount of window space, even for a modern structure.

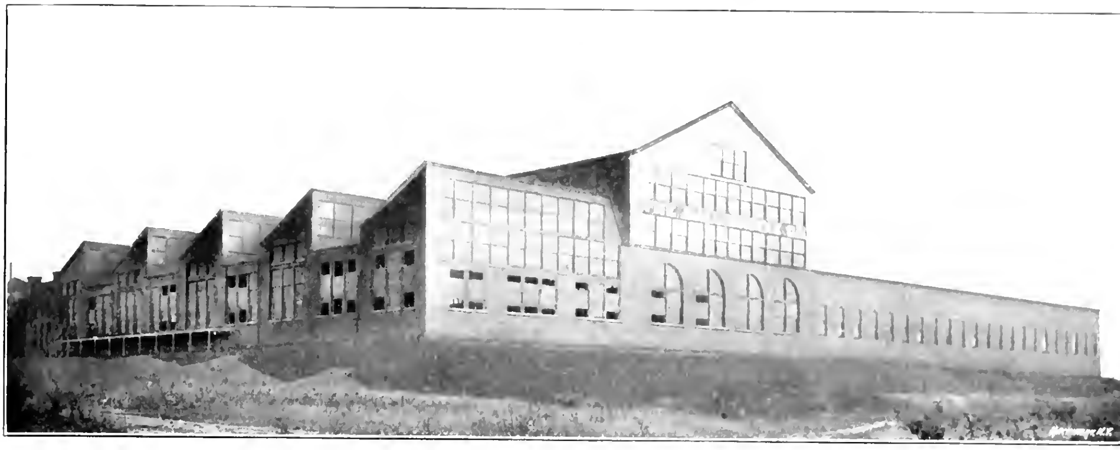


Fig. 1. General View of Ball Engine Co.'s Plant.

The main, or central part of the building, is the erecting shop, 70 feet wide by 200 feet long, with a wing on either side lighted by saw-tooth roof. The floor plan of the plant, showing the layout of the tools, is given in Fig. 3. The larger of the two wings is devoted to the manufacture of engine parts, and contains all but the largest of the machine tools. The smaller of the wings is occupied by the power plant, smith shop, store room, wash room, etc. There is also a carpenter shop and storage building, shown in plan in Fig. 4 which joins the main structure at A, Fig. 3, and will eventually form the connecting building between the machine shop and the foundry. At present the company are using their old foundry adjoining their old works in the heart of the city, but a new foundry is contemplated in the near future.

Fig. 2 is an interior view of the erecting shop and shows the excellent lighting secured by means of the side and end windows. The floor is served by a 25-ton Pawling and Harnishfeger crane, with head room of 55 feet under the crane. There are jib cranes suspended where needed from the columns on either side serving radial drills, an open-side planer, and other heavy tools located in this department. In Fig. 2 a part of the machine tool or manufacturing department is visible, under the wing at the right. This department is served by

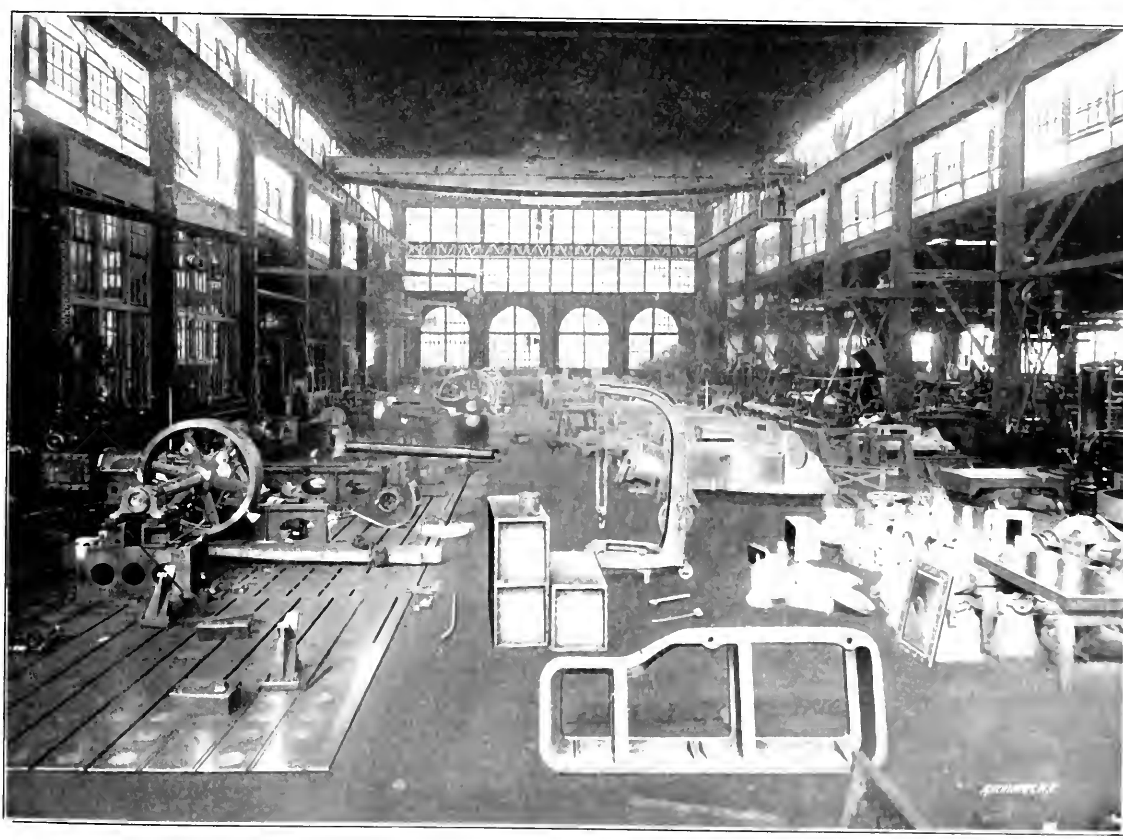


Fig. 2. Interior of Erecting Shop. Machine Department at the Right, Storeroom, Etc., at the Left.

3-ton overhead traveling cranes, the tracks of which extend into the space of the erecting shop far enough to enable loads to be transferred from the smaller cranes to the 25-ton crane in the erecting shop.

The most novel feature of the plant is the design of the saw-tooth roof used for the two lower sections or wings. As shown in the interior view, Fig. 9, and also in the side elevation, Fig. 8, the saw-tooth parts of the roof alternate with flat sections several feet in width. Also, referring to the transverse section, Fig. 11, it will be noted that the saw teeth do not extend clear up to the erecting shop, but are beveled off, as indicated. The main object of this is to allow the wind to circle around the saw teeth of the roof, thus clearing the spaces between from snow. It incidentally provides a passageway on the roof beside the erecting shop wall and allows light to freely enter all the side windows of the erecting shop, where otherwise the saw teeth would obstruct part of the windows. The flat portions of the roof between the saw teeth prevent the snow banking up in the gutters, shutting out light and causing leaks, troubles that occur with the regular type of roof.

In the small tool department, a view of which is shown in Fig. 9, the countershafts are suspended beneath the saw-tooth sections, and beneath the flat places of the roof are located three-ton traveling cranes for serving the different tools. The machine shop floor, excepting the heavy tool foundations, is of concrete 12 inches thick in which are imbedded sleepers covered with tar, and maple flooring is laid on the sleepers.

An interesting feature of the erecting shop is the testing floor shown in Fig. 6, which is made up of cast-iron plates containing T-slots, on which engines of any size may be erected for testing. The illustration shows parallels on the testing plate on which smaller engines are mounted. The pipes leading from the steam main for connecting up the engines under test are fitted with universal joints. This allows the connections to be made easily and quickly without hunting up pipe fittings.

All parts of the plant are piped for compressed air, and an

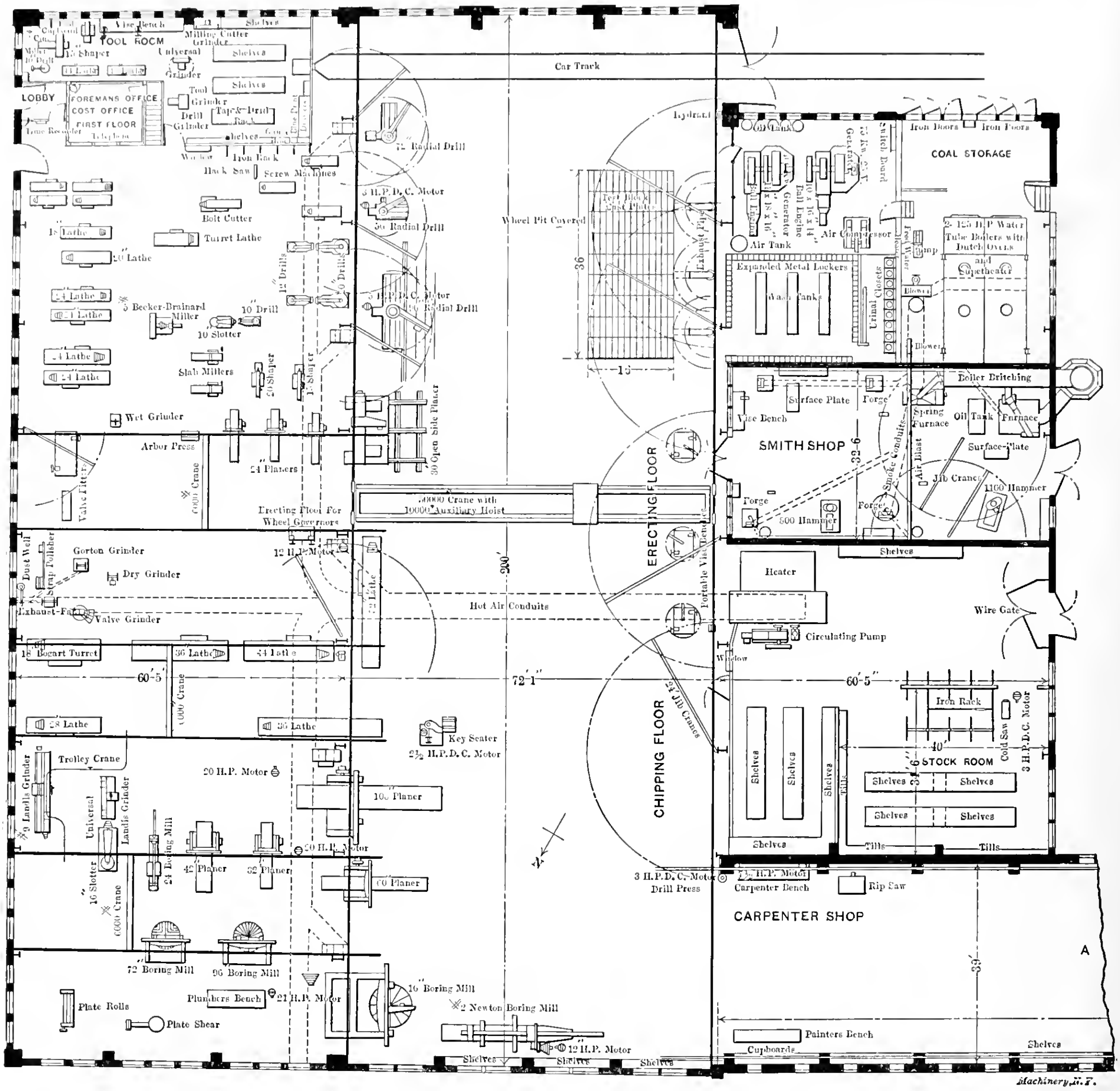


Fig. 3. Plan of Works, showing Lay-out of Tools.

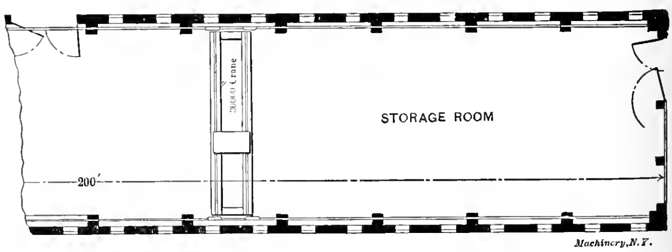


Fig. 4. Recent Addition for Storage. Joins above Plan at A.

air compressor is located in the engine room. In as much as steam is required intermittently for testing purposes, often in as large or larger quantities than for the power plant itself,

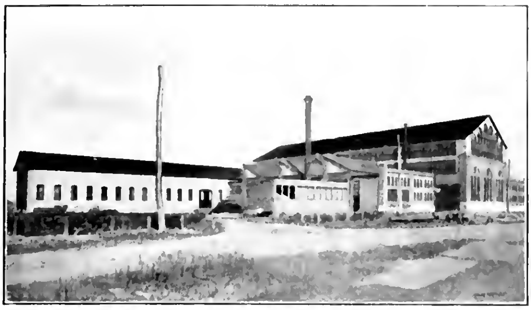


Fig. 5. View showing Storage Wing, Power House, Etc.

the boilers are equipped with mechanical draft and steam in any quantity, up to the maximum capacity of the boilers, can be generated, according to the requirements. In addition to forcing air under the boilers, the same blower is so connected as to exhaust the smoke and gas from the smith shop.

The grouping of the tools, as shown in Fig. 3 has been very carefully arranged to allow work of like character to be done in the same departments and to provide for the regular progress of the work through the shop, all parts moving toward the erecting floor. The supplies and manufactured stock are conveniently located immediately adjoining the erecting floor. The building can be enlarged, as future growth demands, by increasing its length or width or both. The offices are still situated at the old works in the heart of the city, but eventually will be in quarters at the new plant.

* * *

THE SHOP AND THE HOME.

HOW GEORGE MADE THE CAM FOR THE B. & S. MACHINE, AS TOLD BY HIS FOREMAN AND HIS WIFE, EMMA.

The Foreman—"Yes, George is a good man; he is a neat workman, steady, and is well liked by the other men. He has a good head on him, too. When they got in the first B. & S. screw machine they wanted it started up on a different job than what it was originally fitted up for, and there had to be a new cam made for driving the gripping and cutting off movements. I asked George if he could do it, and he said: 'Yes, I guess so, if you give me a little time.' 'Take all the time you want,' I said, and he went ahead and made the cam

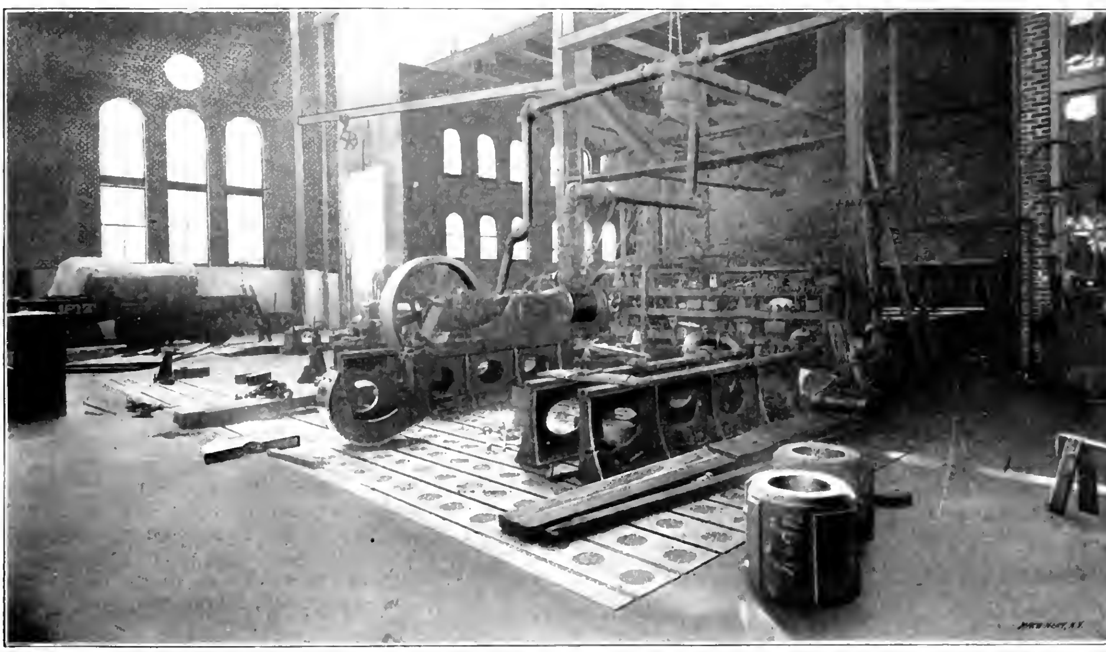


Fig. 6. Testing Plate in Erecting Shop.

and it worked all right the first time he tried it, and now he lays out all of them, and the milling machine man cuts them out. He has his odd spells, though; he came in one morning with fire in his eyes and asked for a raise and said he wanted

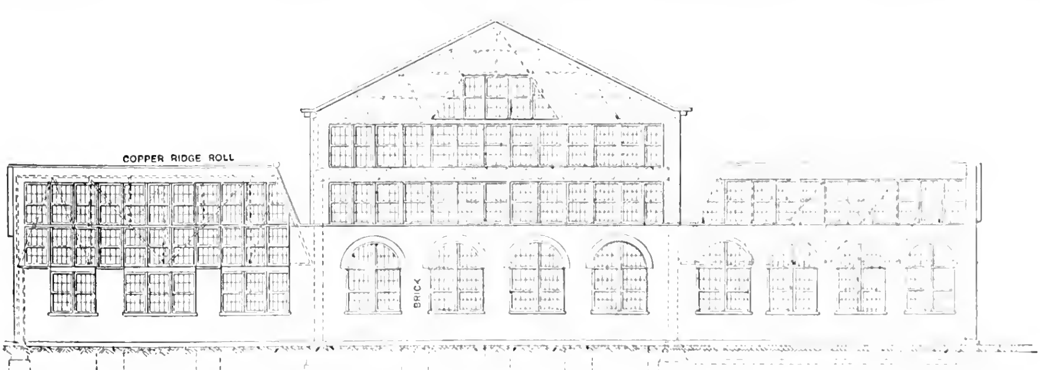


Fig. 7. End View of Shop showing Passage-ways between Saw-tooth Roof Sections and Side Walls of Erecting Shop

it right then and there, or his discharge. We were paying him $3.25 per day, and I had meant to make it $3.50 long before, and I told him so, and so it was all right. But I never could understand why he was so hot about it. If it had been some men I should say he had been drinking, but he don't touch a drop, so I know that was not it. * * * Well—— Good day."

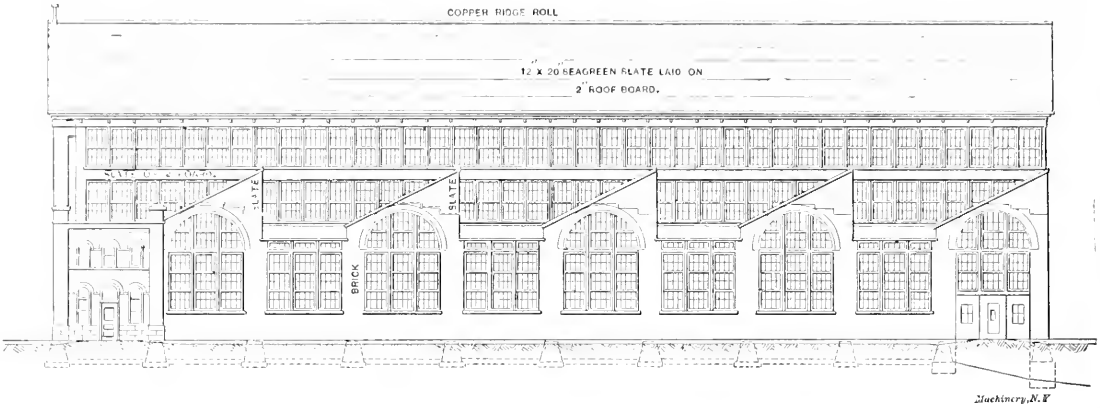


Fig. 8. Side View showing Alternate Saw-tooth and Flat Sections of Roof.

thought of it. Emma says that I talk wheels too much home anyway, but I guess that's a thing that all the women say. Well—So long."

Emma—"Yes, George is still working at the B. E. Co. It's a real steady shop, and it is so close to the house that the baby can watch him clear down to the gate from the window, and I guess he will stay there right along. * * * No, I really don't know what the work is, but I think some of it is real large. I know he had a cam to make several weeks ago, and it was 20 degrees one side and 15 degrees the other, so I know it must have been awful big. I know a degree was 69½ miles when I went to school, but I don't understand how they ever could have got it in the shop if it was as big as that; anyway, what do you think? George had hold of while he was making it. I woke up one night with an awful pain in my neck, and what do you think ? George had hold of my shoulder and was twisting it as hard as he could, and when I asked him what he meant he said that he was dreaming about that cam, and that he was trying to set it ahead a little to make it work better. I don't know what he meant, but I know my shoulder is lame yet. There was one night when he got up to warm the baby's milk. You know we use that little lamp with the tin chimney on it nights, and he had warmed the milk, and instead of turning it into

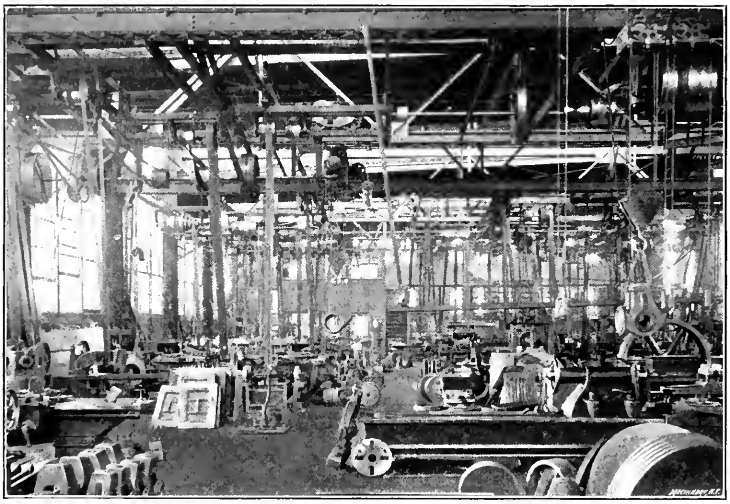


Fig. 9. Interior of Machine Department, in one of the Saw-tooth Roof Wings.

George—"Yes, I am still at the B. E. Co. and I guess I will stay there as long as I live. It's a good shop and a good crowd to work with, and you get lots of nice jobs to do and a chance to use your head; more than you would in some shops. When the first B. & S. screw machine came in we had to set it up for a new screw from what the tools were designed for, and the 'Old Man' had me lay out a new cam. It was a very interesting kind of a job; you see it was like this: It had to have 30 degrees to cut off in, and then a 30-degree dwell, and then 15 degrees more to back out in, and all I had to do was to give it one-third more dwell, and then time it so it would still do the work and get away soon enough for the chuck to open and let the rod feed in the next piece, say 8 or 10 degrees. It looks real easy and simple as I explain it to you, but it took me two days to get it through my head, but it is very easy now, you see, don't you? Yes, I got a raise a time ago, and the 'Old Man' said he meant to have done it long ago, if he had only

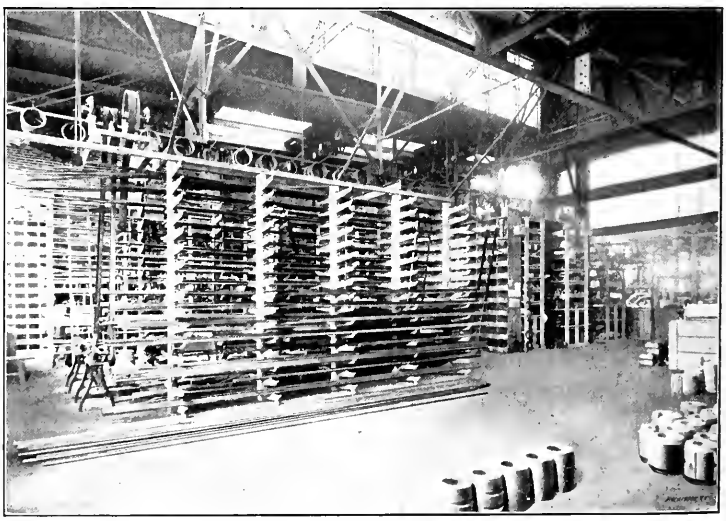


Fig. 10. Stock Rack.

the bottle he turned it down the chimney. Of course the light went out; it left us all in the dark, and when I asked what he meant he said he was thinking about that cam. But he got it braced him up good, and then I sat in the window and watched him clear down to the shop and told him to go straight to the boss as soon as he got into the shop and go for it. They gave it to him, and said they would have given it to him long before if he had only spoken of it. * * * Yes, the baby is real well and we are getting along nicely; only I hope George won't have to make any more cams.

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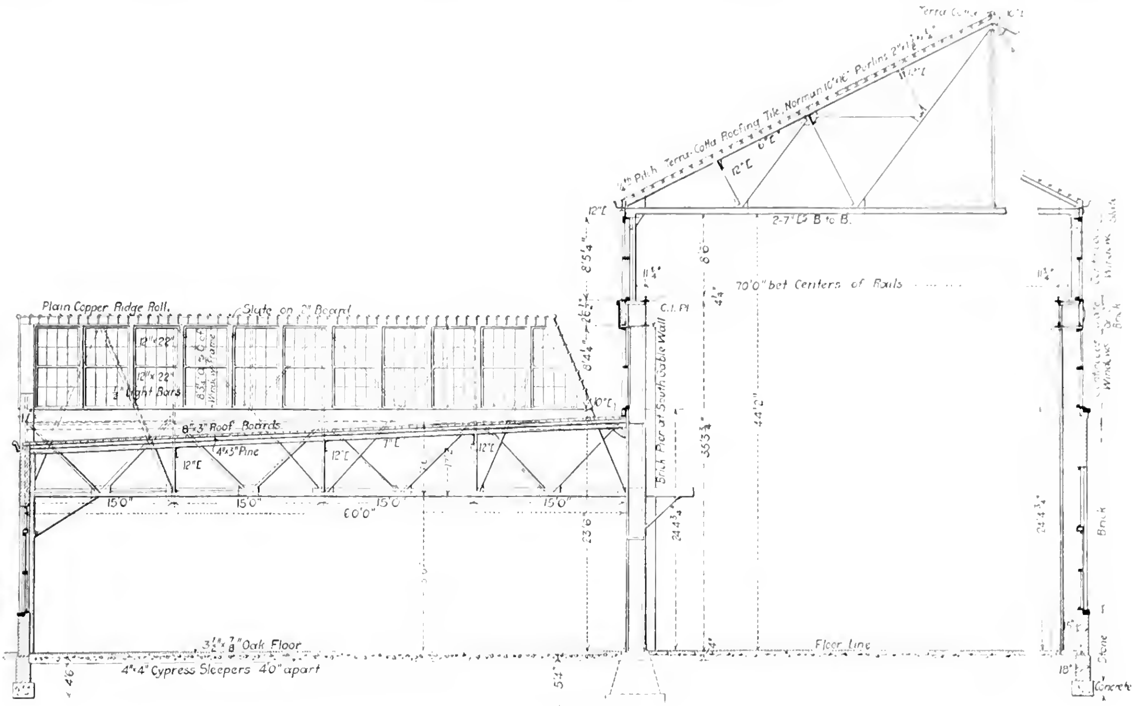

Fig. 11. Half-section of Plant.

done finally, and he has made two or three since then, but I guess they must have been small ones; they didn't seem to bother him anyway. * * * Yes, he got a raise but a little time ago. I talked and talked, but he was afraid he would get fired if he asked, and finally I told him I would take in washing if necessary to keep the house going until he got another job. Then one morning I got an extra good breakfast and I

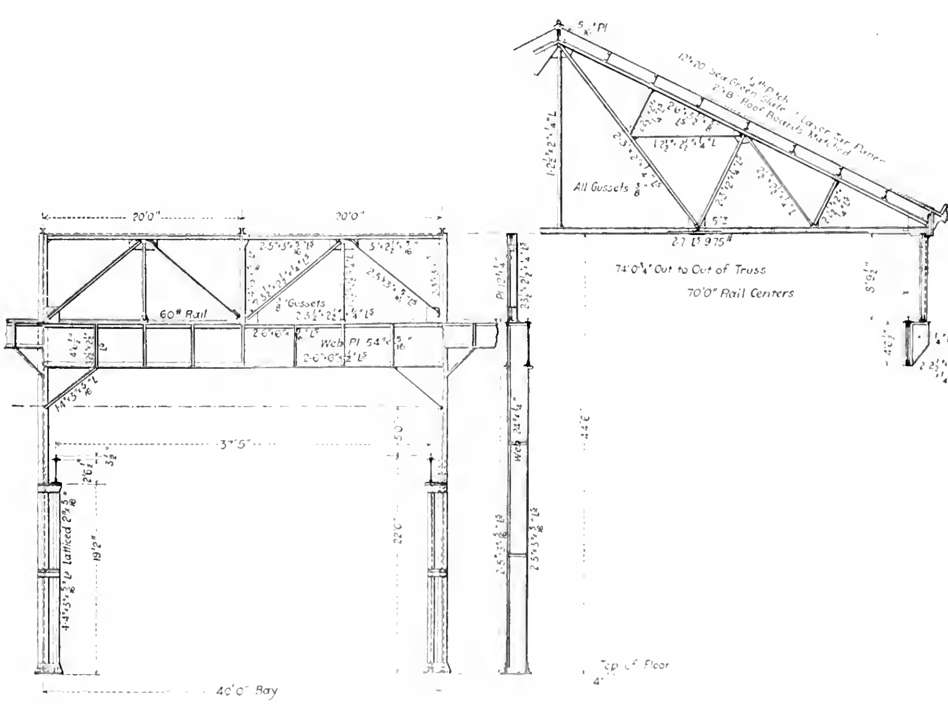

Fig. 12. Details of Roof of New Storage Building and of Erecting Shop.

Don't put a piece of work in a vise to make centerpunch marks, or stamp steel figures on it, but lay it flat on a good solid bench-block.

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MARCH, 1906.

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* * *

Two miles in 58 4-5 seconds by the 200 H. P. French Darracq car; and one mile in 28 1-5 seconds by the 50 H. P. American Stanley steamer. These are the records of this year's races at the Ormond-Datona beach, eclipsing all previous efforts to get over the ground by means of a motor-driven vehicle. But what of it? It is creditable to our manufacturers that materials and workmanship have reached so high a degree of perfection that a machine will stand the strain of such a contest—more creditable than that thousands of people take delight in watching foolhardy adventurers risk their lives in driving the machines in this phenomenal time. But nevertheless such contests are of no value to the manufacturer and in no way help him to produce a car of greater utility to the general public.

* * *

A NEEDED MACHINE.

An illustration of the difficulty of making a practical machine in which the government is vitally interested is the postage stamp sticking machine. To our knowledge there is no practical machine for sticking postage stamps on letters, although the demand for such a machine is considerable. The difficulty of the problem lies in the fact that postage stamps come in sheets gummed and perforated. A postage sticking machine should, of course, have the stamps printed in strips which should not be perforated but should be slightly notched on each side at the junctions of adjacent stamps. With the stamps prepared in this manner the problem of a successful sticking machine becomes a comparatively simple one but where the invention is restricted to the use of stamps in the present form the difficulties are so great as to make the scheme in all probability impractical. To get the government officials to print stamps in strips and supply them rolled, ready for use in such a machine would require great influence and pressure and is something that would likely cause a scandal on account of appearing to favor a patented device which in the nature of the thing must be a monopoly. The solution of the problem would seem to be to assign the basic patent to the public, something after the case of the vertical plane car coupler. As is well known the McConway & Torley Co., who owned the basic patent on the vertical plane coupler, assigned it to the public so that it could be made the standard type, which could not have been done if the field had not been an open one. This firm took their chances with competitors, reserving only their minor patents which were on details not necessary to the principle of the device. With the postage sticking machine, if it could be made to appear that the basic idea was open for competition and there were a number of manufacturers making machines which differed in details only and who were competing for business, then it would seem that the way would be clear to put up the postage stamps in the desired form. It should be stated in this connection that firms mailing large quantities of matter, not first class, have the option of paying postage in bulk where the mail is sent under certain postoffice supervision and thus the use of stamps is avoided, but this does not apply to letters and other first-class matter.

* * *

NAVAL ENGINEERS BECOMING SCARCE.

Something over five years ago the "Personnel Bill" went into effect, by which the engineering corps of the navy was abolished and engineers were to become officers of the line, or officers of the line were also to become engineers, as the case might be. In other words, it now devolves upon an officer or engineer of the navy to become proficient in seamanship, in gunnery and in engineering, the latter not only including the care and operation of marine machinery but its design and construction as well.

Engineer-in-Chief C. W. Rae of the U. S. Navy states in his annual report that owing to the absence of specific instructions in the Personnel Bill, combined with "powerful adverse influences," absolutely nothing has been done by the younger officers of the line in acquiring engineering experience. He therefore sounds the note of alarm and says that with the diminishing of the number of older men of the engineering corps the country is approaching a state where it would be in no condition to win battles in war. Our guns cannot be carried to the firing line and kept there witth amateurs in charge of the machinery, and no officer out of the academy a short time, who would not even be given charge of the deck except under the supervision of his senior officer, should be placed in charge of the engineering of a ship as has been done.

The Personnel Bill has been the target for frequent bombardment by the press, and Chief Rae feels called upon to defend it, although he suggests needed modifications in its workings. He contends that engineering as applied to the propulsion of ships logically belongs to the line and the main reasons for this opinion appear to be that there are not enough positions of high rank to secure proper promotion of two sets of officers—the engineers, and the officers of the line; that there are controversies and jealousies where there are two bodies of officers performing duties on shipboard; and that there is a widespread prejudice throughout the service against the formation of a separate corps of engineering specialists.

In common with many others not connected with navy, but who are more or less acquainted with human nature, we think the "jealousies" and 'widespread prejudice" have been more influential in bringing about the new order of things than has common-sense judgment. Some may make good sailors, proficient engineers, expert gunners and capable machine designers in the time ascribed to the allotted age of man, but men who can do this are scarce.

* * *

Where the flywheel of a steam or gas engine is made with curved spokes it should be mounted on the crankshaft so that the outer curve of the spokes is backward. This puts the iron of the spokes in compression in transmitting the power developed in the cylinder. If the flywheel be put on in the reverse position with the outer curve of the spokes forward the spokes are put in tension in transmitting the power; this is not good practice in cast iron construction although in the case of the flywheel the rim is always in tension, due to the centrifugal stress, but it is unavoidable. Placing the wheel as directed increases the stress in the flywheel rim because of the reaction of the spokes. The rim, however, is always made much heavier and stronger than the spokes and, moreover, is not so likely to be weakened by casting strains.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

According to a statement in the *Horseless Age* the practice of slightly offsetting the center line of gasoline engine cylinders with respect to the axis of the crankshaft has been adopted by a number of the leading French automobile manufacturers. This practice, it is said, originated with the Westinghouse Machine Co. in 1886 when they first placed on the market their two-cylinder, high-speed, single-acting steam engine fitted with trunk pistons. The result of offsetting the cylinder is that the side pressure of the piston on the cylinder wall due to the thrust of the connecting-rod is decreased during the power stroke and increased during the compression stroke, but as the compression pressure is much lower than the expansion pressure the increase of side pressure during the compression stroke is less important than the decrease of side pressure during the expansion stroke. Consequently the cylinder wear should be decreased.

The time switch is an electrical device that has been found useful for automatically switching on the lights in show windows, says the *Electrical Age*. The clock governing the switches can be set so that a sign or show window would be lighted at a predetermined time and after burning for the desired period would be automatically switched off. An extension of this scheme that might not be unprofitable in some cases would be the lighting of offices, drawing rooms and even shops. There is a tendency, as is well-known, for men when absorbed in their work to continue working without sufficient light and until some one realizes the lack of light there may be a number of workers suffering from eye strain. With the automatic time switch the lights would be turned on at a certain time each day. The serious drawback to such a scheme is that in the winter months when light is most needed the time for lighting changes each day for the same weather conditions, and changes in the weather make the time for lighting up very irregular.

In a recent bulletin issued by the B. F. Sturtevant Co., Boston, Mass., is listed a series of "gas boosters" manufactured by them which serve the very useful purpose of increasing the pressure of illuminating or fuel gas in gas mains. While the arrangement is very simple it is one that probably not all of our readers are familiar with. A valve is placed in the gas main and a by-pass is connected, leading around from one side of the valve to the other. The booster, which is a special form of rotary exhaust fan, is placed in the by-pass and draws gas from the supply on one side of the stop valve and delivers it to the other side at an increased pressure. It is stated that the light obtained from the burners supplied by gas delivered by the blower is perfectly steady and that the light is not distinguishable from that coming from a burner fed by gas delivered by the regular gas-holder pressure. This method of pressure boosting is applicable in the localities where the consumption has outgrown the capacity of the pipes or in hilly towns where low-lying districts fail to get sufficient pressure. It also overcomes the resistance caused by frost in pipes, and in manufacturing plants the pressure may be increased to offset the effect of small pipes or to supply gas furnaces, brazing tools, testing laboratories, etc. It apparently simplifies the problem of employing gas as a fuel, which is having an ever widening field of usefulness.

The steam turbine marked a great step forward in our type of prime mover, giving much needed relief from the limitations of reciprocating engine practice. Engineers are now finding that, apart from its merit as a prime mover, its effect on power plant design will be far-reaching in the direction of simplicity and reduction of original cost. So far, turbines have, as a rule, been installed in power plants more or less conventionally designed on the lines of piston engine practice, but we will soon have typical turbine plants, with their various other features and general arrangement co-ordinated to the simplicity and compactness of turbine design, and much of the present-day complexity, with its attending expense, will disappear. Two plants are now being designed—one for Fort Wayne, Ind., the other for Hamilton, Ohio—in which this general idea will be carried out. The boilers will be on the ground floor, and the turbine located directly overhead; thus the steam and exhaust runs will be short and direct, the initial steam coming up and the exhaust going down, as they should. The exciters are put on the generator shaft, thus eliminating separate exciting units; in fact, the stations will contain as little in the way of auxiliaries as possible. There will be some saving in building construction, considerable saving in ground space, and it would not be surprising if the whole station, including ground, were to show a reduction in first cost per kilowatt of 25 per cent on the usual capital account of such properties.—*Edward H. Sniffin in Electric Journal.*

The details of an interesting test of a Curtis steam turbine are given in the January, 1906, issue of *Power*. The turbine was a 500-kilowatt capacity and was installed in the Oshkosh, Wis., Gas Light Co.'s plant. The following tabulated data gives the economy at various loads of the final test.

Half load, 250 kw.—25.99 lbs. steam per kw.-h.:	
Average barometer	29.40 in.
Average vacuum	26.79 in.
Average initial steam pressure	150.00 lb.
Average quality of steam	98.20 %
Full load, 499 kw.—22.64 lbs. steam per kw.-h.:	
Average barometer	28.97 in.
Average vacuum	26.40 in.
Average initial steam pressure	141.75 lb.
Average quality of steam	98.20 %
Overload, 22.2%, 611 kw.—22.28 lbs. steam per kw.-h.	
Average barometer	29.01 in.
Average vacuum	26.40 in.
Average initial steam pressure	142.20 lb.
Average quality of steam	98.20 %
Commercial run, average real kw., 262.7—26.34 lbs. steam per kw.h.:	
Average barometer	29.24 in.
Average vacuum	26.29 in.
Average initial steam pressure	146.00 lb.
Average quality of steam	98.20 %

The above results are corrected for step-bearing overflow and condenser leakage.

The one-half, full and 122.2% loads are rheostatic and non-inductive and measured at the switchboard.

RAPID WEAR OF MODERN GUNS.

Annual Report of Brig. Gen. Wm Cozier, Chief of Ordnance.

Accompanying the use of the larger charges of powder there was introduced a new element limiting the life of guns, namely, that of erosion of the bore. This was very great in the neighborhood of the seat of the projectile, and very decided in its action, scoring and guttering the surface in a manner which required its renewal after a certain number of rounds. The life fixed by this process, however, was not unreasonably short, a 10-inch gun being capable of enduring from 250 to 300 rounds before requiring relining, so that the question of limiting the power because of this difficulty was scarcely considered. With the general use of smokeless powder, however, with its still better control of the rate of burning, and the great increase in the powder charges and in the velocity, the subject of the wear of the bore has greatly increased in importance. This wear is of a different kind from that described above, being unaccompanied by the deep guttering of the surface which was experienced with the powder immediately preceding, but the smooth and even wearing away of the surface proceeds with such rapidity that after some 50 or 60 rounds from large guns the rifling is so worn away that the projectiles are no longer given the motion of rotation necessary to steadiness of flight, and inadmissible loss of accuracy results. There has, therefore, been brought about a serious consideration of the question whether the guns should not be used at a power less than that which their strength enables the realization of, in order to diminish the erosion and increase the life.

THE WORKS OF AN AXE.

Could the city dweller, says "Backwoods" in the *Woodworker*, who knows the axe only as an implement for reducing packing boxes to kindling wood, and who handles it with but little more dexterity than does his wife, take a tramp in the backwoods—the way-backwoods—he would see much that would cause him to wonder at the works of that little-esteemed tool.

Many a residence is built and furnished with no other tool, except maybe a pocket knife for the finer work; while the addition of an auger to the kit enables the builder to indulge in luxuries. More than one mid-winter night has the writer spent most comfortably in a house and on furniture, which bore the marks of no other tool, unless one designate as a tool the large nail which was used to burn the holes in the wooden hinges of "the big front door."

The pioneer who "blazes the trails," travels light; and, when he builds a residence miles from any road over which a horse could be urged, which is to serve till he is "crowded out"

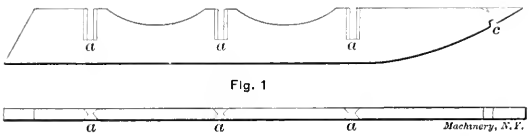


Fig. 1

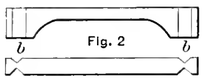


Fig. 2

by a neighbor within a mile or two on either side, well nigh all his wants must be supplied by the axe alone. While it wouldn't be good form to say so in a story, yet in real life it is a fact that more of his food wants are supplied through traps and snares made with an axe, than are by his rifle; and, be it a candlestick, a washbasin or a bedstead, he meets the want from the natural growth around him, wrought with this one omniferous tool.

It was at one of these country residences that the writer saw a practicable hand sled, axe-made, the parts of which are shown in plan and side views in the accompanying sketch. Fig. 1 shows the runners, split and hewn from straight-grained birch, with the notches *a a a* cut so that the bunks shown in Fig. 2, notched as shown at *b*, will fit snugly therein. No nail, screw, bolt nor any metal part was there; the bunks were simply dropped into place, a rope of leatherwood bark tied in the notches *c*, and the vehicle was ready to load.

The six-cylinder gasoline engine built by the Wolseley Tool & Motor Car Company, of Birmingham, England, for railway motor cars has taken on an additional interest to Americans on account of its contemplated use by the Delaware & Hudson Co. in their new motor car being built by the General Electric Co. at Schenectady, N. Y. The Wolseley engines have been used with much success by the North-Eastern Railway Co. on a type of motor car wherein a gasoline engine is used to drive a generator which furnishes current for the motors driving the car. The engine, which is to be used by the Delaware & Hudson Co., is built with horizontal cylinders, three opposing cylinders being on each side of the crankshaft. The opposing cylinders are not directly in line but are offset the width of the crank, by which construction each pair of pistons are always moving in opposite directions, thus giving perfect balancing. The cylinders are 9 inches diameter and 10 inches stroke and the flywheel weighs 780 pounds. The practice of the North Eastern Railway in regard to starting has been to use electric accumulators, but the new engine for the Delaware & Hudson Co. is to be started by the explosion of cartridges in the engine cylinders. A special breach mechanism is provided and cartridges of ordinary sporting size containing from 280 to 300 grains of black powder are found to give a cylinder pressure of about half the ordinary working pressure. These cartridges are successively exploded by special mechanism in conjunction with the timing gear for the usual electric ignition. Three cartridges only are employed in as many cylinders for starting, the other three cylinders drawing in charges the same as under working conditions so that the initial movement communicated by the explosion of the cartridges is at once taken up by the working cylinders which go into regular operation. For the details enumerated in the foregoing we are indebted to the November 10, 1905, issue of *Engineering*.

EFFECT OF RAPID CHANGES IN THE VELOCITY OF WATER.

A report has recently been published by the British Engine, Boiler and Electrical Insurance Co., Ltd., in which are described a number of peculiar accidents and breakdowns that have occurred in connection with steam and gas engines. One incident was in connection with a pump which delivered water through a three-inch pipe to a tank 38 feet above the pump. One day it was noticed that the valve chamber of the pump was cracked and the explanation apparently was that the force required to accelerate the column of water in the discharge pipe on the opening of the delivery valves was great enough to have done the damage, particularly if the pump were discharging at only a part of its capacity, so that between the intervals of discharge the water in the vertical pipe would lose its upward velocity. A calculation made by the writer of the report indicates that the pressure might have been between 900 and 1,000 pounds per square inch from this cause. The speed of the pump was such that the water in the discharge pipe had been accelerated to a velocity 48.6 feet per second with the discharge valve open, while it is estimated that before the valve opened the velocity must have been less than 31 feet per second. Therefore, at the moment of opening the delivery valve the velocity of the 116 pounds of water in the pipe had to be increased in a very short period of time at least from 31 feet per second to 48.6 feet per second. The length of time available for affecting this increase would depend on the leakage past the piston, but if the time were 0.01 second, the force required to change the velocity would equal 925 pounds per square inch. While these figures are not known to be correct, they show that rapid changes of the velocities of water cannot be effected without producing very great pressure.

The magnitude of the forces required to put long columns of water into motion in short spaces of time are often much underestimated. This remark may be illustrated by a case which came under the notice of one of the company's inspectors. A steam pump single acting, with a plunger 1 9/16 inch diameter by 4¾ inch stroke, running about 62 revolutions per minute, received its supply from a tank through a 1-inch lead pipe 3 feet long leading vertically downward from the bottom of the tank, and coupled at the bottom by a union to a wrought-iron elbow carried vertically downward for 12 inches, and then horizontally for 2 feet to the suction valves of the pump. The water level in the tank was 2 feet 3 inches above the bottom, and, therefore, 5 feet 3 inches above the union connecting the lead to the wrought-iron pipe. The pump had been running practically day and night for 14 years, during which time the lead pipe had gradually bulged out into a globular shape just above the union, and finally it burst. The bulging was due to the pressure set up by the stoppage of the flow when the suction valve closed.

PORTABLE HAND SHAPER OR PLANING MACHINE.

In a recent issue of the *Practical Engineer* a novel hand planing machine was illustrated and described which can be mounted in a bench vise, being clamped with the work, and in this position the work may be planed off by reciprocating the tool head by means of a lever, as is shown in Fig. 2.

As will be seen from Fig. 1, the apparatus consists practically of two parts, the lower part *a* representing a semi-cylindrical trough, the longitudinal edges of which are the guides for the slide *c*, and of the ram *b*, holding the planing tool. The ram *b* is moved backward and forward by means of a lever, and the feed is effected either by hand or automatically. For the purpose of working it automatically there is a rectangular slot *u* through which a star-shaped wheel *o*

passes, which acts as a nut to the leading screw *s*. Underneath the opening *u* two jaws *v* are provided, with smooth holes for the screw *s*, and between which the wheel *o* is held. As the leading screw *s* is prevented from moving longitudinally by a nut, the wheel o, when turning, will move in the direction of the longitudinal axis of the leading screw *s*, and carry with it the intermediate slider *c*, by pressing against one of the jaws *v*. In order to turn the wheel *o* use is made

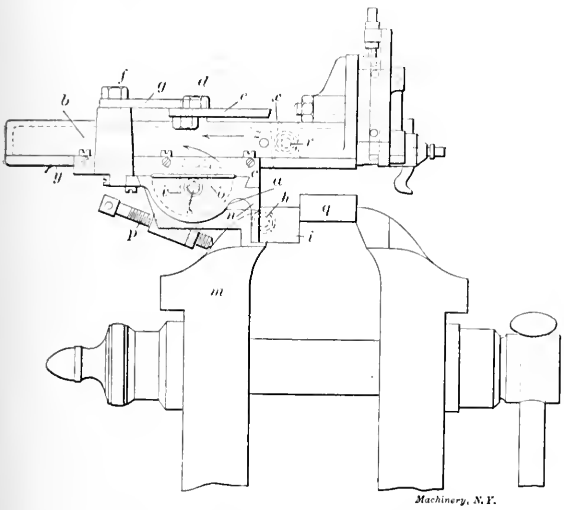


Fig. 1. Side View of Hand Planing Machine.

of the carrier *b*, inside which a swinging catch *x* is suspended, which can only swing to the left hand, whereas on the right hand it comes in contact with the stop *r*, which prevents it from swinging in that direction. On the return movement of the carrier in the direction of the arrow, the catch *x* pushes against a point of the wheel o, turning the latter through a certain angle, whereas in the forward movement

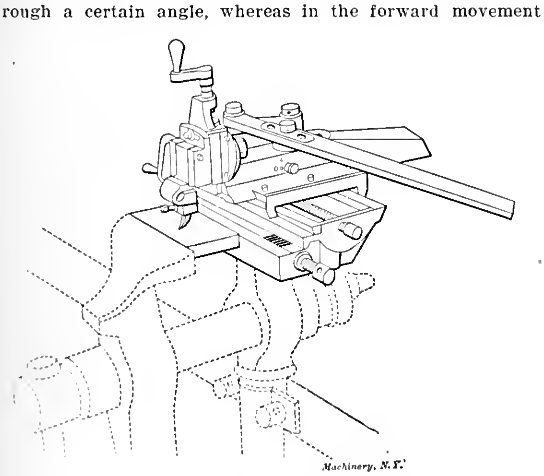


Fig. 2. The Machine at Work in the Vise.

of the carrier the catch *x* gives way in the direction of *z*, without any effect upon the wheel *o*. If the stop *r* is put in on the left hand the self-acting movement of the slide *c* is effected in the opposite direction. The tool is made by the Union Standard Machine Co., 165 Queen Victoria Street, London, E. C.

THE PROBLEM OF THE GAS TURBINE.

Robert M. Neilson, in Power, January, 1906.

The success of the steam turbine has led many engineers to expect success with turbines impelled by gaseous products of combustion. A gas engine using coal gas or producer gas, and having no reciprocating parts, would be a very desirable prime mover if it had an efficiency equal to that of existing gas engines of equal power. There are, however, formidable difficulties in the way of producing such a machine. With any gas engine, reciprocating or turbine, compression is necessary in order to obtain a good efficiency; and in reciprocating gas engines it has been found (as was to be expected from theoretical considerations) that the greater the compression, the greater the efficiency until practical developments (such as preignition) come in to prevent higher compression. Now the higher the compression, the more important is it to have efficient compression. A rotary compressor which will be efficient for high pressures is therefore necessary before an efficient wholly-rotary gas engine can be produced. Now, we do not seem to have at present a satisfactory and efficient rotary compressor which can deliver air at, say, 100 pounds per square inch. Turbine compressors, such as made by C. A. Parsons & Co., in England, have much to be said for them, but unfortunately they do not seem to be efficient for high pressures.

The heat losses in a gas turbine demand serious consideration. Steam entering a steam turbine, even with a fairly high superheat, has a temperature very much below that existing in a gas-engine combustion chamber. Water-jacketing or other means are adopted in a reciprocating gas engine to keep the cylinder and other parts from getting overheated; and a certain amount of heat is thus lost which otherwise would have been converted into useful work. The gas, however, taken as a whole, is not brought into very intimate contact with the artificially-cooled parts. If, however, a mass of intensely hot gas, such as usually exists in the center of an Otto engine combustion chamber just after the beginning of the expansion stroke, were allowed to pass into a turbine, say, of the Parsons type, the blades of the turbine, even if they could be water-cooled sufficiently to stand the heat (which is doubtful in the case of some of them), would absorb such a quantity of heat energy from the gas as to leave comparatively little for conversion into useful power. The expansion of the hot gases in divergent nozzles and the mixing of them with a cooler fluid have been proposed, with a view to reducing the temperature of the gases before they reach the turbine proper.

In De Laval steam turbines, the steam before coming into contact with the turbine wheel is expanded in divergent nozzles from the initial pressure—say, 200 pounds per square inch—to approximately the exhaust pressure, which may be that of the atmosphere or of a good condenser. This expansion is done—and done very satisfactorily—in a single stage in divergent nozzles which convert the available heat energy (minus small losses due to friction, etc.) into kinetic energy. The steam issues with a very high velocity and a comparatively low temperature from the nozzles, and, entering the turbine buckets, drives the wheel. If we were to expand gaseous products of combustion in divergent nozzles the same as is done with steam in De Laval steam turbines, we could with a suitable choice of working conditions obtain a temperature at the outlet ends of the nozzles such as a turbine wheel could stand. Our knowledge of the expansion of elastic fluids, other than steam, in divergent nozzles for use with turbine wheels is, however, almost nil; and experiments must be made before we can say with confidence whether as good results may be expected with gaseous products of combustion as can be obtained with steam.

The mixture of the hot gaseous products of combustion with water before use in a turbine would allow of the temperature being very much reduced. Unless, however, the ratio of water to gas were very high, the temperature of the resultant mixture would still be too great for it to be suitable for use in a turbine unless divergent nozzles were employed to reduce the temperature still further before the mixture was allowed to come into contact with the rotating vanes.

If the proportion of added water to products of combustion were great, then the fluid would be very much like superheated steam, which always contains, in practical steam-engine work, a certain amount of air. The turbine could then be built like any of the common forms of steam turbine, and a condenser could be employed. The non-condensable gases would have to be removed by an air pump; and the power to drive this air pump, which might be very considerable, would have to be taken into consideration.

FOR GREATER ECONOMY OF THE GAS ENGINE.

The conditions affecting the economy of the internal combustion engine as well as some suggestions for the improvement of economy were reviewed in a recent issue of *Gas Power*. While the gas engine is already the most efficient prime mover known, the economy is seriously affected by the loss of heat transmitted to the walls and piston. When an explosive mixture of gas and air is burned in the cylinder the heat, save that which is used in performing work, leaves the mixture very rapidly especially in the smaller sizes and quickly appears in the water jacket or cooling flanges. A pound of gasoline vapor when burned slowly in air develops about 22,000 B.T.U., or, in other words, sufficient heat is developed to heat 22,000 pounds one degree F. Air, however, takes much less heat to raise its temperature than water so that the same quantity of gasoline would raise the temperature of about 132,000 pounds of air one degree F. The simplest way, therefore, in which a quantity of fuel may be made to do the most work is to make it heat a large quantity of air, adjusting the quantity of air in such proportion that at the temperature and pressure used the extra quantity of air would absorb all the heat otherwise wasted in the jacket. This, however, means weak mixtures, and weak mixtures are difficult to burn except under very high compression. Under high compression gasoline mixtures are likely to explode prematurely but this trouble may be avoided by compressing in two stages so that in the second stage the mixture enters the cylinder cool enough to prevent premature combustion when compressed in the power cylinder.

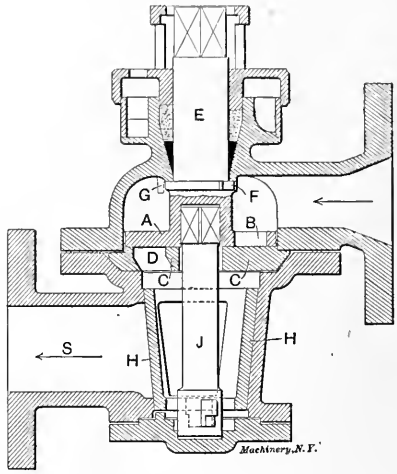
Another method which avoids the use of the air pump necessary in the foregoing requires the cylinder to be arranged so that part of the exhaust is used over again, a tank being so connected to the engine that just at the end of the working stroke when the exhaust pressure is still under 30 or 40 pounds pressure a portion of the exhaust is made to enter the tank through an automatic non-return valve. From this tank the cooled exhaust gases are admitted to the cylinder after the regular explosive charge has been drawn in. This method is open to the objection that the mixture is weakened by the introduction of the exhaust gases containing little oxygen and that a large radiating surface is required for the cooling chamber.

A third method is to inject with the regular charge a small quantity of water which will absorb the heat and generate steam. The objection to this, however, is the extreme delicacy required in regulating the quantity of water used. A very small amount is needed in the smaller sizes of gas engines and an excess will interfere with the ignition and make the action unreliable. That it is a difficult matter to regulate the quantity of water will be indicated when it is stated that in engines having say 3 x 3-inch cylinders the plunger displacement of the water pump should only be about equal to that of a cylinder 3/16 inch diameter and ¼ inch stroke, and on a 6 x 6-inch cylinder it would still be small, being only about that contained in a cylinder ⅜ inch diameter by ½ inch stroke. In short, the water injection idea seems impractical for gas engines of less than 20 H. P. There are also other practical difficulties with the water injection scheme, it may be added which militate against it.

HOPKINSON'S BOILER BLOW-OFF VALVE.

A combined disk and plug valve boiler blowoff valve is described in the *Mechanical Engineer* in which the actuating mechanism is so designed that, as soon as the plug is fully open, it remains stationary in that position until the disk valve completes its opening movement, and also remains stationary while the disk valve is closing, and not until the disk valve is fully closed does the plug or cock begin to move, the same being finally closed by the continuation of the turning movement of the valve spindle in the same direction. The advantage of this arrangement is that the packing and edges of the thoroughfares of the plug or cock and of its seat are at no time subjected to the scouring action of the liquid or fluid.

A is the valve which is subject to the pressure of the liquid, the same consisting of a rotary disk furnished with an opening *B* forming the thoroughfare and working on a seat *C*, having a similar opening *D*, which is opened and closed by turning the disk. The disk is actuated by a socket wrench or key applied to the spindle *E* and the extent of the opening movement is governed by a stop *F* on the spindle, and a corresponding stop *G* on the cover of the valve casing. In combination with the disk valve *A*, and turned by it, is a hollow plug *H*, working in a seat in the casing, and having an opening in the wall, which opening when brought into agreement with the opening *S* in the casing forms the outlet. The construction and arrangement are such that when the spindle *E* is turned for the purpose of opening the valve, the thorough-



fare in the plug *H* opens first and is fully opened before the thoroughfare through the disk valve *A* begins to open and conversely when closing the valve the thoroughfare in the plug remains open until the thoroughfare in the disk valve is fully closed, so that the plug is neither being opened nor being closed while there is a flow of liquid through the casing, and the faces of the plug and seat in the casing upon which dependence is placed for securing fluid tightness are therefore not subjected to the passing currents when blowing through. The valve is made by J. Hopkinson & Co., Huddersfield, Eng.

EARLY HISTORY OF STEAM WARMING AND VENTILATING IN AMERICA.

R. T. Crane, in the Valve World.

The history of heating and ventilating engineering in this country commences with Joseph Nason, who, upon his return from England in the latter part of 1842, began the introduction into this country of the Perkins system of hot-water heating, with which Mr. Nason was thoroughly familiar, having been for some years, while in England, in the employ of Mr. Perkins. Mr. Nason and his brother-in-law, James J. Walworth, formed a partnership and bought out the New York agency of John Russell & Sons, well-known English manufacturers of buttweld pipe. Shortly after Mr. Nason's return to this country, it was decided that Boston would be a better location than New York, so the firm moved to that city. A short time afterward several orders for heating apparatus were received; among them, a contract was secured for warming the counting-room of the Middlesex Mill, in Lowell, which was warmed by the Perkins system, and was the first heating work done in this country by Mr. Nason.

In 1845 the Eastern Exchange Hotel, East Boston, was equipped, this job being of particular interest, as in the apparatus, while steam was used as a heating medium, the surface, following the Perkins hot-water practice, was all made of three-quarter-inch pipe, and it is the first instance on record, either in this country or abroad, where small pipe was used for steam heating. During the same year a mill at Burlington, Vt., was heated by exhaust steam with three-quarter-inch pipe, which is the first instance where a mill was warmed in this manner. Previous to Mr. Nason's going into the business, several mills had been warmed by passing exhaust steam into large cast-iron pipes.

In 1846 a radical departure in the method of heating—in

this country at least—was made by the warming of the Boston custom house by means of mechanical propulsion of air. A large coil of three-quarter-inch pipe was massed in the basement, and from it to the several registers were run ducts of sufficient capacity to carry the warmed air. This plan of warming, while not new to France, was entirely novel in this country, and was the beginning of all subsequent systems in which fans were employed for distributing air. The fact that this plan of warming had already been employed in France does not detract from the credit due to Mr. Nason, as there is no evidence that while abroad he went to France, and it is highly probable that he was not familiar with the progress that had been made in that country.

In the same year the Naumkeag mill in Salem was heated with exhaust steam, the job being notable, as in the exhaust pipe was placed a back-pressure valve, which was designed for the purpose, and was the first of its kind. Heating by exhaust steam soon became well known, and was in considerable repute because of the saving effected in fuel consumption by using steam which would otherwise be wasted. All these jobs were laid out so as to throw but little back pressure on the engine.

In 1852 the partnership existing between Mr. Nason and Mr. Walworth was dissolved. Mr. Nason went to New York, taking over the firm's business in that city. The earlier work done by him in that city was largely on dwelling-houses, though many public buildings were warmed, not only in the vicinity of the city, but throughout the country.

In 1855, in which year extensive alterations of and additions to the United States Capitol at Washington were in progress, Mr. Nason, at the request of Gen. Meigs, then in charge there, went to Washington and planned a system of ventilating and heating for the Capitol. This was the first really scientific and complete job of the kind done in this country. Mr. Nason, as this job at the Capitol shows, had a thorough knowledge of the business as it was then known, and was at the time unquestionably the best informed and most experienced person on heating and ventilating in the United States.

The apparatus installed under Mr. Nason's direction consisted primarily of a heating surface of wrought-iron pipe, over which air was forced by means of two specially designed centrifugal fans, and conducted through ducts to the rooms to be heated and ventilated. It will be remembered that both the halls of Congress are inside rooms surrounded by corridors and rooms. Inasmuch as the warmed corridors and rooms protected the meeting halls from the cold, it was not necessary to warm the halls, consequently air was introduced at a temperature of 70 degrees. So far as we know, this is the only case of the kind that ever occurred.

In order to meet these conditions, the heating surface was massed in at least two sections, one section being used for heating the air intended solely for ventilating purposes, another section being used for heating air intended for warming purposes.

This plan of having a large amount of heating surface located in one place and the air blown through it, the heated air being then conducted to such places as it was needed, was for some years the favorite mode of heating. Some years after a job of this kind was put in the new post office at Washington. It was also placed in several insane asylums. It was soon abandoned, however, for the distributing plan of heating surface as now universally carried out.

In this connection I would mention an incident that occurred about the year 1855, which, while not connected with heating engineering, brings out a fundamental business principle which has always been impressed upon my mind. Senator Floyd, of Virginia, was at the head of the committee in charge of the post-office job, and he insisted on letting the contract to a firm in Richmond that was not in this line of business. General Meigs, a man of great engineering ability and integrity, vigorously protested against Mr. Floyd's action in this matter, and wanted the contract placed with the only person in this country who had had experience and shown ability in this line of work, namely, Mr. Nason of New York.

Before leaving the Capitol, in connection with the lighting and ventilation, a matter which had much to do with the comfort of the halls of Congress might be mentioned as illustrating the good judgment used in arranging the halls. Whether Mr. Nason or General Meigs was personally in charge of this work we do not know. In order to prevent the gas lights (gas was then used for lighting the halls) from vitiating the air of the rooms, they were placed above the glass ceilings. In this way the combustion of the gas did not interfere with the perfect ventilation of the halls. One of the peculiarities of the system was the method of igniting the gas, which was made necessary by the fact that the jets were distributed over the entire ceiling, and consequently could not be lighted by hand, and they were so far apart they would not ignite from each other. To meet the situation, the engineer in charge ran an extra gas pipe over the ceiling, on which pipe the jets were so close together that when one was lighted the flame would run the length of the pipe. These smaller jets were so located in reference to the regular burners that when the gas was turned on the main line each burner was lighted. Then, of course, the gas was turned off the igniting system.

This recalls a rather unique method of lighting inaccessible burners I saw in Berlin. A row of jets was located in the dome of an arcade. A little wagon, equipped with propelling machinery, ran around a track, carrying a torch to the burners.

POWER PLANT ECONOMICS.

Abstract of Paper read before the American Institute of Electrical Engineers by Henry G. Stott, Superintendent of Motive Power, Interborough Rapid Transit Co., New York.

The development of the steam turbine during the past three years has resulted in marked changes and improvement in power plant engineering as a whole. The superheater has been revived and so developed that superheat of 200 deg. or 300 deg. is feasible. With the study of the superheater question has come increased attention to the furnace, which will probably be still further improved. Another important result has been the development of condensing apparatus to such a point of efficiency that a vacuum within one inch of the simultaneous barometer reading can now be maintained without difficulty. Another change has been the reversion to high-speed generators, resulting in decreased cost of the generator and its foundations, as well as a saving in floor space. And last but not least the steam turbine has put the reciprocating engine and the gas engine on the defensive and has actually been unkind enough to throw out hints in regard to the application of Dr. Osler's proposed methods to the treatment of older apparatus.

The reciprocating engine and internal-combustion engine have not been slow in accepting this challenge; they have responded by showing so improved an economy (especially in the gas engine) that the situation has become most interesting to the power-plant designer. It is safe to say that the developments of the next ten years will show very marked improvement in power-plant efficiency.

In Table 1 will be found a complete analysis of the losses found in a year's operation of what is probably one of the most efficient plants in existence to-day and, therefore, typical of the present state of the art.

TABLE 1. ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL INTO ELECTRICITY.

	B. T. U.	Per Cent.
1. B.T.U. per pound of coal supplied*	14,150	100
2. Loss in ashes	340	2.4
3. Loss to stack	3,212	22.7
4. Loss in boiler radiation and leakage	1,131	8.0
5. Returned by feed-water heater*	441	3.1
6. Returned by economizer*	960	6.8
7. Loss in pipe radiation	28	0.2
8. Delivered to circulator	223	1.6
9. Delivered to feed-pump	203	1.4
10. Loss in leakage and high-pressure drips	152	1.1
11. Delivered to small auxiliaries	51	0.4
12. Heating	31	0.2
13. Loss in engine friction	111	0.8
14. Electrical losses	36	0.3
15. Engine radiation losses	28	0.2
16. Rejected to condenser	8,524	60.1
17. To house auxiliaries	29	0.2
Total except items marked *	11,099	99.6
Total of items marked *	15,551	109.9
Delivered to bus-bar	1,452	10.3

In regard to this development the author wishes to direct attention to the basic fact that in power plants one should not look merely for increased efficiency in the prime mover, but should also investigate and analyze the entire plant from the coal to the bus-bars; first, in regard to efficiency; secondly, in regard to the effect of load-factor upon investment; and thirdly, the effect of the first and second upon the total cost of producing the kilowatt-hour, which is the ultimate test of the skill of the designer and operator.

Mr. Stott discusses at length the various items in the above table, and reference to a few of the important points brought out will be made. The thermal value of the coal used is evidently of prime importance, as it affects the cost efficiency of the entire plant. The method of purchasing coal used in the plant from which this heat balance is derived is that of paying for B. T. U. only, with suitable restrictions on the maximum permissible amount of volatile matter, ash, and sulphur. A small sample of coal is automatically taken from each filling the weighing hoppers, so that the final sample represents a true average of a boat-load of coal. This final average sample is then pulverized and tested for heat value in a bomb calorimeter, after which a proximate analysis is made of another portion of the sample. This method of purchasing coal has been in use for two years, with highly satisfactory results. The loss to the stack is one of the most vulnerable points of attack as the loss of 22.7 per cent is very large. Recent investigations show that promising results may be obtained by the use of more scientific methods in the boiler room. In practically all cases it will be found that this loss is due almost entirely to admitting too much air to the combustion chamber, resulting in cooling of the furnace. This result is usually produced by "holes" in the fire; these "holes" may be due to several causes, but usually are due to carelessness on the part of the fireman.

Fortunately, a very valuable piece of apparatus in the way of a CO_2 recording gage is now to be had, which shows the condition of the gases in the chimney and enables us to know when the furnace is operating properly.

The loss in boiler radiation and leakage, amounting to 8 per cent in the table, is largely due to the inefficient boiler setting of brick which, besides permitting radiation, admits a large amount of air by infiltration. This infiltration will increase with the draught, thus tending to exaggerate the maximum and minimum points on Fig. 6. The remedy for this radiation and infiltration loss is evidently to use new methods of boiler setting, such as an iron plate air-tight case inclosing a carbonate of magnesia lining outside the brickwork.

Mr. W. H. Patchell, of London (see paper read Dec. 7, 1905, before the Institution of Electrical Engineers), has introduced very large boilers, assembling two in one setting; each boiler has a normal evaporation of 33,000 pounds per hour and in this way has cut down to a minimum the radiating surface per square foot of heating surface. He has also introduced the iron case with magnesia lining, and with good results.

The question of boiler leakage is one in which the choice of the lesser of two evils is necessary; for in the tubular or cylindrical boiler the leakage will undoubtedly be less than in the water-tube type, owing to the smaller number of joints in the water space. But these two advantages are offset by the increased difficulty of construction, and the danger of using large boilers of the tubular type, with high-pressure steam.

It is now generally admitted that there can be no more difference in the efficiency of different types of boilers under similar conditions than there can be in electric heaters, press agents to the contrary notwithstanding.

We will now take up certain of the items of Table I in detail.

Item 6. Owing to the difficulty of pumping water at temperatures above 150 degrees Fahr., when under pressure, it becomes necessary to install economizers for the purpose of increasing the feed-water temperature to 200 or 250 degrees Fahr. As this increase of temperature is obtained from the waste gases at no expense for fuel, it only becomes necessary to consider the load-factor, as will be shown later, in order to decide whether economizers should be installed or not. In practically all cases where the load factor exceeds 25 per cent the investment will be justified.

In deciding upon the size of economizer to be installed it is important to consider first, the influence of the economizer upon the available draught due to the obstruction it offers and also due to the reduced stack temperature; the second important consideration is to equate the interest and depreciation charges against the saving in fuel, and so determine the amount of investment justified in each particular case.

Items 8 and 9. Heat Delivered to Circulating and Boiler-Feed Pumps. As these auxiliaries may be either electrically driven or steam driven it is interesting to note that the thermal efficiency of the electrically-driven pumps would be equal to the thermal efficiency of the plant, multiplied by both the efficiency of conversion from the alternating to direct current and by the motor efficiency. In this case, there would be a net thermal efficiency of $10.3 \times 0.93 \times 0.90 = 8.63$ per cent, whereas the thermal efficiency of the steam-driven auxiliary discharging its exhaust into a feed-water heater at atmospheric pressure would be approximately 87 per cent.

Item 13. Loss in Engine Friction. Recent tests of a 7,500 horse power reciprocating engine show a mechanical efficiency of 93.65 per cent at full load, or an engine friction of 6.35 per cent. As this forms only 0.8 per cent of the total thermal losses it is relatively unimportant. Attention is called to the method of lubricating all the principal bearings by what is known as the flushing system, whereby a large quantity of oil is put through all the bearings by gravity feed from elevated oil reservoirs common to all the units; after passing through the bearings the oil is returned by gravity to oil filters in the basement and then pumped up to the reservoir tanks again. About 200 gallons per hour are put through each engine, and of this quantity only about 0.5 per cent is lost. This method of oiling undoubtedly contributes to the general result.

Item 14. As large electrical generators can now be obtained which give from 98 to 98.5 per cent efficiency, it would seem as if the limit in design had been reached and that hereafter the problem of design is to be merely one of altering dimensions to suit varying sizes and speeds. While this is true as far as the efficiency is concerned, other problems are continually arising, such as the design of generators for an overload capacity of 100 per cent to meet the demand for apparatus capable of taking care of great overloads economically for short periods, corresponding to peak loads of a railroad or lighting plant.

In Fig. 1 is a diagram of steam consumption per K. W. hour of a 7,500 H. P. Allis combined vertical and horizontal compound engine of the Allis type. In Fig. 2 is a typical economy curve of a steam turbine. An inspection of this curve, which represents what is probably the best results obtained up to date, shows: first, that the best economy on dry saturated steam is practically equal to that of the reciprocating engine in Fig. 1; secondly, that 200 degrees superheat reduces the steam consumption 13.5 per cent. But calculating the total heat units in superheat from $H_1 = H + 0.48\ (t_2 - t_1)$ the B T. U. per kilowatt-hour are 20,349 for dry saturated steam, whilst for 200 degrees superheat they are 19,008 or a net thermal saving of 6.6 per cent. The shape of the economy curve, however, is much flatter than that of the reciprocating engine, so that the all-day efficiency of the turbo unit would be considerably better than that of the reciprocating engine, with the other great advantage of costing approximately 33 per cent less for the combined steam motor and electric generator.

Reciprocating Engine with Turbine using Exhaust Steam.

The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke as in the reciprocating engine; there is an almost ideal thermal drop from the steam valve to the condenser. It is also evident that the expansion will be relatively more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, so that it has been proposed that the reciprocating engine should be run high pressure where relatively it is more efficient than the steam turbine, utilizing the turbine for the low-pressure part of the cycle. In other words, use each where it is most efficient.

The following calculations show approximately what might

be expected from such a combination. Assuming that the 5,000-K. W. reciprocating unit would take 50 per cent more steam when operating non-condensing than when condensing there would then be (see Fig. 1) a consumption per kilowatt-hour of 25.5 pounds.

Steam expanding between the absolute pressure of 190 lb. and 14.7 lb. would give up 165.3 B. T. U. per lb., or a total of 4,215 B. T. U. per kilowatt-hour.

The total heat in the steam at 190 lb. absolute is 1,197, so that the heat units left for the turbine would be

$$(1{,}197 \times 25.5 - 4{,}215) \times 5{,}000 = 131{,}542{,}500 \text{ B. T. U.}$$

The B. T. U. per kilowatt-hour for a turbine unit operating on a dry saturated steam (see Fig. 2) were 20,349, but owing to the wetness of the steam at atmospheric pressure the efficiency of the turbine would in all probability be reduced to about 70

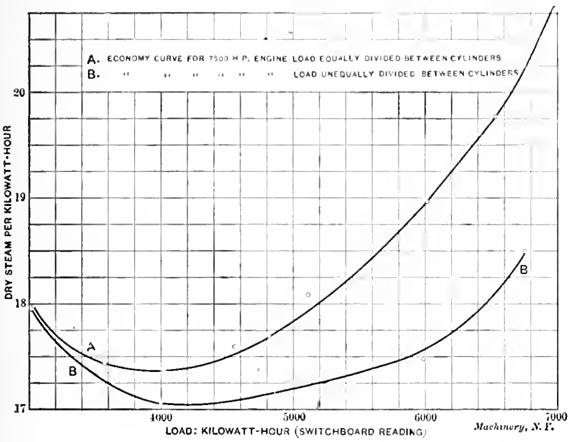


Fig. 1. Economy Curves of Allis Vertical-horizontal Engine.

per cent so that the steam consumption of the low-pressure turbine would be increased to 29,070 B. T. U. The total power, available from the turbo generator would then be 4,807 K. W.

We thus find that for a total of 152,617,500 B. T. U. we now get 5,000 K. W. from the reciprocating unit and 4,807 K. W. from the turbo unit or a total of 9,807 K. W. at a cost of 15,562 B. T. U. per kilowatt-hour.

This turbo unit would be interposed directly between the exhaust nozzle of the reciprocating engine and the condenser, and would have no valves or governing mechanism whatever. The generator would be connected directly to the other generator leads without any switching apparatus, except possibly knife switches to disconnect for testing purposes; and in operation no attention whatever would be required beyond the ordinary lubrication of bearings. Such a unit it is evident could be built at a very small cost per kilowatt.

The Internal Combustion Engine.

The gas engine has probably developed more slowly than any other piece of modern apparatus, as it is now thirty years since the Otto gas engine was introduced. It is only within the last ten years that the larger type of engine, from 500 to 2,000 H. P. in size, has appeared. The delay in bringing forward the most efficient motive power known is chiefly due to the difficulty experienced in developing an efficient and inexpensive method of making gas. As far as the production of gas from anthracite and non-caking bituminous coal is concerned this problem has apparently been solved, but it is still in a more or less unsolved condition for the richer bituminous and semi-bituminous caking coals of the Eastern States.

The great objection to the use of the gas engine for electrical purposes has been: first, its lack of uniform angular velocity; secondly, its uncertainty in action and high cost of maintenance; and thirdly, its inability to carry heavy overloads. Recent developments have removed the first and second objections; and a period of vigorous development has resulted in placing the gas engine in the front rank of claimants for attention as a prime mover.

The total investment for a gas producer plant, all auxiliaries, gas engines, and electric generators, has been reduced by the elimination of the gas-holding tank to a point where it is now practically on a par with a first-class steam plant using high-grade reciprocating engines.

The accompanying heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas.

ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL CONTAINING 12,500 B. T. U. INTO ELECTRICITY.

	B.T.U.	Per Cent.
Loss in gas producer and auxiliaries....	2,500	20.
Loss in cooling water in jackets........	2,375	19.
Loss in exhaust gases..................	3,750	30.
Loss in engine friction.................	813	6.5
Loss in electric generator.............	62	0.5
Total losses........................	9,500	76.0
Converted into electrical energy....	3,000	24.0
	12,500	100.0

Where natural gas or blast-furnace gas can be obtained the gas engine has outdistanced all competitors; and now that some of our large manufacturers have taken up in earnest the problem of designing producer-gas plants, it is safe to say that rapid developments will result.

The records of operation of several important installations of gas engines in power plants abroad and in this country seem to indicate that only one important objection can be raised to this prime mover, and that is that its range of economical load is practically limited to between 50 per cent load and full load. This lack of overload capacity is probably a fatal defect for the ordinary power plant, more especially for the average railroad plant operating under a violently fluctuating load, unless protected by a storage battery of comparatively large capacity.

New Type of Plant.

Over a year ago, while watching the effect of putting a large steam turbine having a sensitive governor in multiple with reciprocating engine-driven units having sluggish governors, it occurred to the author that here was the solution of the gas-engine problem; for the turbine immediately proceeded to act like an ideal storage battery; that is, a storage battery whose potential will not fall at the moment of taking up load, for all the load fluctuations of the plant were taken up by the steam

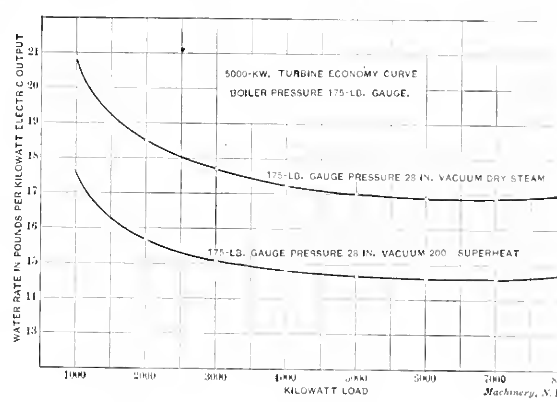


Fig. 2. Economy Curves of 5000 K.W. Turbine.

turbine, and the reciprocating units went on carrying almost constant load, whilst the turbine load fluctuated between 0 and 8,000 K. W. in periods of less than 10 seconds.

The combination of gas engines and steam turbines in a single plant offers possibilities of improved efficiency whilst at the same time removing the only valid objection to the gas engine.

A steam-turbine unit can easily be designed to take care of 100 per cent overload for a few seconds; and as the load fluctuations in any plant will probably not average more than 25 per cent, with a maximum of 50 per cent for a few seconds, it would seem that if a plant were designed to operate normally with 50 per cent of its capacity in gas engines and 50 per cent in steam turbines, any fluctuations of load likely to arise in practice could be taken care of.

We have seen that the thermal losses in the gas-engine jacket-water amounted to approximately 19 per cent, and as

the water is discharged at a temperature above 100 deg. it can be used to advantage for boiler feed. Mr. Stott estimates and gives figures to show that the total average thermal efficiency of such a plant would be 24.5 per cent.

TABLE 2. DISTRIBUTION OF MAINTENANCE AND OPEARATION. CHARGES PER KILOWATT HOUR.

	Reciprocating Engines.	Steam Turbines.	Reciprocating Engines and Steam Turbines.	Gas Engine Plant.	Gas Engines and Steam Turbines.
MAINTENANCE.					
Engine room mechanical....	2.57	0.51	1.54	2.57	1.54
Boiler room or producer room	4.61	4.30	3.52	1.15	1.95
Coal and ash handling apparatus	0.58	0.54	0.44	0.29	0.29
Electrical apparatus........	1.12	1.12	1.12	1.12	1.12
OPERATION.					
Coal and ash handling labor	2,26	2,11	1.74	1.13	1.13
Removal of ashes..........	1.06	0.94	0.80	0.53	0.53
Dock rental................	0.74	0.74	0.74	0.74	0.74
Boiler-room labor...........	7.15	6.68	5.46	1.79	3.03
Boiler-room oil, waste, etc...	0.17	0.17	0.17	0.17	0.17
Coal	61.30	57.30	46.87	26.31	25.77
Water	7.14	0.71	5.46	3.57	2.14
Engine room mechanical labor	6.71	1.35	4.03	6.71	4.03
Lubrication	1.77	0.35	1.01	1.77	1.06
Waste, etc..................	0.30	0.30	0.30	0.30	0.30
Electrical labor.............	2.52	2,52	2.52	2.52	2.52
Relative cost of maintenance and operation............	100.00	79.64	75,12	50.67	46.32
Relative investment in per cent.	100.00	82.50	77.00	100.00	91.20

In Table 2 will be found a tabulation of the relative values of the various items necessary in the maintenance and operation of a power plant. The first column covers a plant with compound condensing reciprocating engines without superheat, and is derived from a year's record of actual costs of a large plant operating with a load-factor in this case being defined as actual output divided by 24 times the maximum hour's load.

The values in the other columns have in the main been estimated from the first column, but wherever possible actual data derived from various sources, both domestic and foreign, have been used; but in all cases all values have been reduced so as to make them directly comparable with the first column, and with one another. The values in maintenance and operation of steam turbines are derived from actual costs.

Summary.

1. The present type of steam-power plant can be improved in efficiency about 25 per cent by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

2. The steam-turbine plant has an inherent economy 20 per cent better than the best type of reciprocating-engine plant, not so much due to its higher thermal efficiency as to a variety of causes shown in Table 2.

3. An internal-combustion engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one-half its present cost.

TESTS OF BELT PREPARATIONS.

We have received from the Cling-Surface Co., Buffalo, N. Y,. a report of tests upon belting treated by different preparations, made by students in the laboratory of Sibley College, Cornell University. The preparations used were Cling-Surface, neats'-foot oil, and two belt dressings, one a solid and one a liquid, which are regularly manufactured as commercial articles. The names of these two dressings are not given in the report, but are designated as "X" and "Z."

Four new leather belts were secured for the experiments. These were first tested in an untreated condition, and then each belt was treated as directed by the manufacturers and run at a high speed for five hours; then laid in a warm place for thirty-six hours; then again treated and run for three hours; then tested. The neat's-foot oil belt, however, to avoid a slippery face, had no last treatment.

The following summary is condensed from the report:

Results from belt with and without Cling-Surface: The untreated belt followed the usual theory of belting, *i. e.*, increase of horse power, with an increase of initial tension. The slip and arc of contact were both steadily reduced with increase of tensions. The effects of Cling-Surface on this belt were marked. The belt was softened, and given a peculiar clinging property without being in the least degree sticky to the touch. It had an extremely high transmitting power, when the initial tension was only the weight of the belt. As tension was increased, this transmitting power decreased until passing about 10 pounds per inch of width of tension, when it increased, and at maximum initial tension the output was about the same as on the lowest tension, but at the cost of the high pressures on the bearings. The slip was in no case over 2 per cent.

The belt treated with neat's-foot oil slipped badly and transmitted less power than when untreated, and aside from pliability the results were adverse.

Of the other two belts, treated with the two belt dressings, one ran with only 2 per cent slip when placed under initial tension, but this increased rapidly and the output decreased as the belt was slackened. The other one became distinctly sticky and power was lost in pulling the belt off the pulley.

Ranking the preparations according to their percentage of horse power delivered, we find this order: 1, Cling-Surface; 2 and 3, the two dressings; 4, neat's-foot oil. Cling-Surface gave 40 per cent more power on lowest tensions than the next highest.

Before the tests were run the four materials were first subjected to chemical tests to ascertain the presence of resin, free alkali, ammonia, mineral and fatty acids. None of the first three were found in any of the materials. Dressing "Z" contained some free mineral acid. The amounts of free fatty acid found is as follows: Cling-Surface, 27-100 of one per cent; neat's-foot oil, 70-100 of 1 per cent; dressing "X," 3.5 per cent.; dressing "Z," 29.85 per cent.

* * *

The seizure, actual and contemplated, of Niagara Falls by private interests to convert it into a huge power manufactory is causing much adverse comment, although it is generally recognized by the engineering profession, at least, that such an enormous natural power should not run to waste. The sentimentalists loudly decry the loss of the scenic beauty of the gigantic cataract and another class argue that private interest should not be given rights in what belongs to the public, etc. But as concerns the first, perhaps there is a possibility of utilizing a large part of the dynamic value of the falls without losing the scenic beauty. Suppose, for example, that an apron or breast of concrete were built at the foot of the falls with its face forced in the well-known cycloid curve, or curve of swiftest descent, by which the vertical fall is converted into a horizontal direction in the manner quite commonly employed to prevent destructive washing at the foot of dams. The vertical flow of water thus having been transformed into a swiftly moving horizontal flow, power development only requires that pipes or flumes for carrying the water against an impulse water wheel be provided, and in this manner a considerable portion of its force could be converted into electric energy. The difficulties of the scheme are enormous, but it suggests the possibility of using the full power of Niagara, inefficiently, it is true, but without serious damage to the scenic grandeur.

* * *

Most of the handbooks give tables containing the area of circles, beginning with a diameter of 1. To use these tables for small diameters, expressed in hundreths or thousandths of an inch, simply prefix to the tabulated area a decimal point and as many places as the square of the fraction requires. For example suppose the area of a circle 0.035 inch in diameter is wanted. Referring to the table we find that the area of a circle 35 inches diameter is 962.11 square inches; hence the area of a circle 0.035 inch diameter is 0.00096211 square inch.

A FLYWHEEL JOB.

There has recently been cast and finished in the foundry and machine shop of H. W. Caldwell & Son Co., Chicago a single half of a large split band wheel, under conditions which make the job of unusual interest. The entire band wheel was originally made by another foundry, but in putting the wheel in place on the crankshaft of the engine, one of the halves was accidently dropped into the pit and broken. It was a planed joint wheel, and such wheels of course are always cast in separate halves, but it is unusual for one foundry to cast one half to match the other half made by some other foundry, of whose cupola mixture or practice nothing is known. Inasmuch as the order for a new half was given the Caldwell Company, they accepted it, analyzed the metal in the old half of

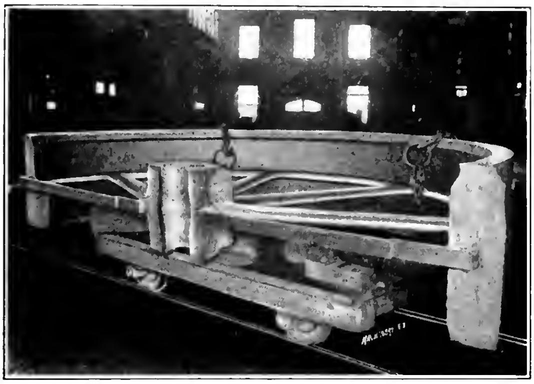


Fig. 1. The Rough Casting.

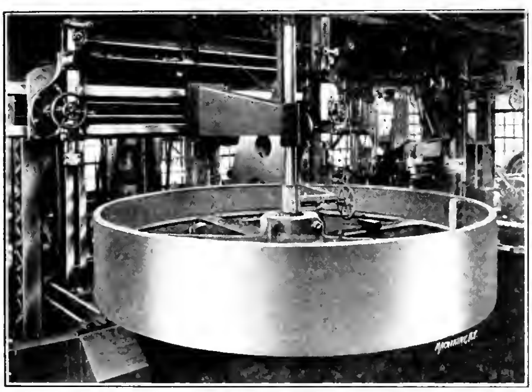


Fig. 3. Boring the Hole.

the wheel, figured out a mixture to give the same shrinkage, moulded a new half in loam, cored out the hub and arms in the ordinary way and cast the wheel section. When the casting had been removed from the pit the first photograph was taken, Fig. 1. After the preliminary work of cleaning, chipping, drilling, facing, etc., had been done the new and old halves were bolted together on the 20-foot boring mill. Part of a cut having been taken around the face of the pulley, the second photograph, Fig. 2, was made. The darker half of the pulley, the one with the chalk marks on it, is the old half, while the other is the new part. The face of the new part was finished and the wheel arranged for the boring of the hub, as shown in Fig. 3. Fig. 4 shows the wheel with the machining operation finished and placed on the balancing ways. The remarkable part of the whole process, and that which shows the work to have been exceedingly well done, is that the finished wheel was found to be only 94 pounds out of balance, the new half being the lighter of the two. The diameter of the wheel is 18 feet, the face 12 inches, the bore 15 inches, and the weight 27,806 pounds.

* * *

Don't always call a helper to pull the ratchet for you or to lift things that you can lift yourself.

MAKING ACCURATE THREAD TOOLS.—1.

It is not an easy thing for a toolmaker to cut a perfect thread or one even closely approximating perfection in its measurements, especially if it be of the United States standard or Whitworth types. It is comparatively easy to shape the cutting edge to an accurate 60 degrees or 55 degrees, depending on whether the American or English form is desired, but the shaping of the point of the tool to accurate dimensions is a matter of some difficulty. The accompanying sketch will show how this is accomplished by one tool maker who is engaged in the manufacture of thread gages, master taps, etc., and who consequently has much of this work to do.

The blank for the tool is made of rectangular shape with a point formed to the proper angle and the rear end carefully

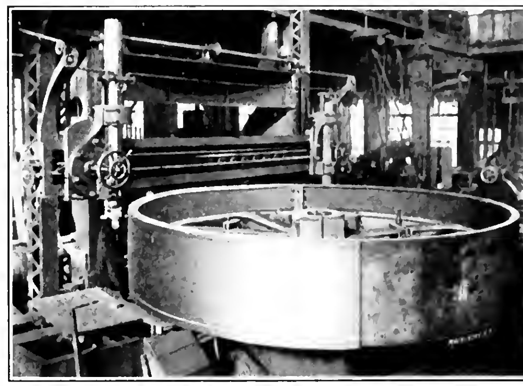


Fig. 2. Finishing the New Casting to Match the Old.

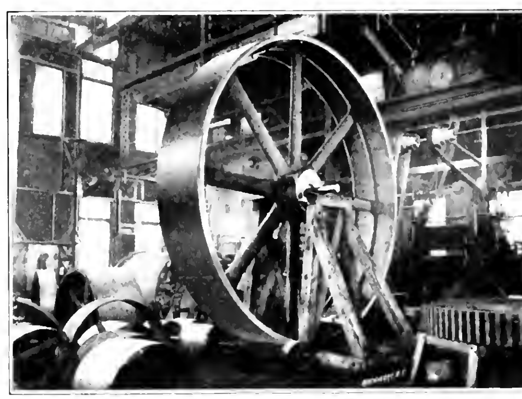
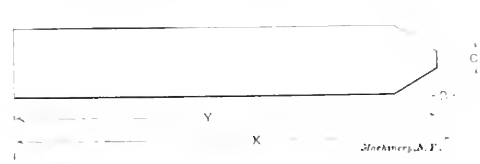


Fig. 4. Balancing the Completed Wheel.

squared. In making the proper flat at the point to cut a United States standard thread it is practically impossible to get dimension C without special instruments. Suppose however that, the sides having been carefully shaped, the distance X from the point of the tool to the rear end is measured with the micrometer. If now the dimension B is known, the point of the tool may be ground off to a distance from the point

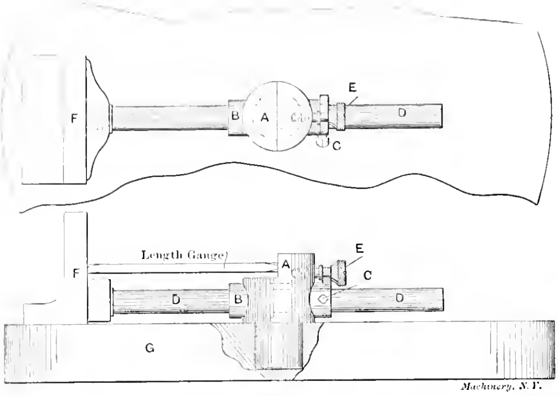


equal to $X - B$ or Y, and if B has been properly calculated we may be sure without measuring it directly that the flat C has the proper width. The dimensions B and C for all usual pitches from 3 per inch up to 100 per inch are given in the data sheet sent with this issue of MACHINERY, and are tabulated there in convenient form for use. Dimensions are also given for the V-thread, the Whitworth, and the Briggs standard pipe thread.

ITEMS OF MECHANICAL INTEREST.

WORK SETTING TOOL FOR LATHE AND BORING MILLS.

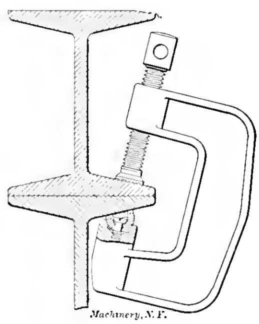
A writer in the *Mechanical World* describes a convenient work-setting tool for lathes and boring mills, particularly the latter. The cuts show the device and its use in setting up the angle plate, *F*, and the same method of use applies when chucking a piece of work off center. The central pin, *A*, which fits the center of the table is bored at right angles to receive the sleeve, *B*. This sleeve is provided with a setscrew, *C*, and a lug on the upper side for the milled head adjusting screw,



Work Setting Tool for Lathe and Boring Mill.

E. The rod *D* is fitted in *B* and one side is flattened for the setscrew, *C*. In use the adjustment is first obtained by sliding the rod *D* to its approximate location, where it is locked by the setscrew, the final adjustment being gotten by the adjusting screw, *E*. The lower sketch also shows how a length gage may be used in connection with the device, a shoulder being provided on the upper end of *A* whose face passes through the center of the table. It is, of course, necessary that the shank of the device fit the boring table hole closely.

SCREW CLAMP WITH SPHERICAL ADJUSTMENT.



An Adaptable Clamp.

Robert Grimshaw sends a sketch of a clamp designed for holding objects, like the flanges of I-beams, that do not present parallel surfaces. It is made of a steel casting and has an I cross section with stiffened back, and if sprung can be brought back to proper shape when hot, like forged ones. The spherical bearing on the under jaw allows all the adjustment out of parallel that is ever likely to be called for.

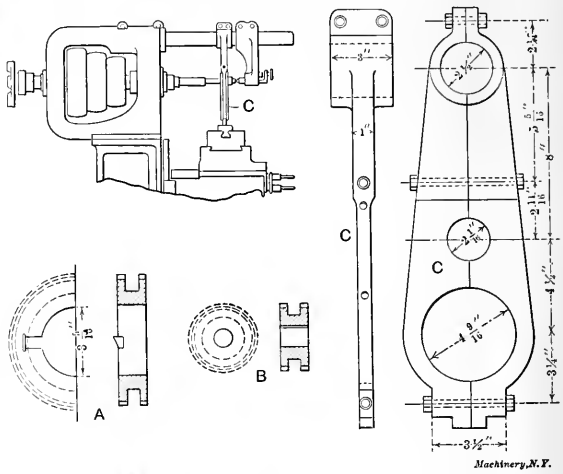
WHAT IS ELECTRICITY?

In the course of a phonographic address which was "machine delivered" before the Electric Club of Cleveland, December 15, Mr. Charles F. Brush said: "The old, old question, 'What is electricity?' is more to the front than ever before, but we need no longer make the old, unqualified and humilating answer, 'We do not know.' We are now fairly on the way to finding out. The brilliant researches and speculations of J. J. Thompson and others seem pregnant with knowledge. We are told that the flying particles, or ether corpuscles, of the Crookes tube are far smaller than the chemical atom; that their mass is little more than the thousandth part of that of the hydrogen atom; that they move with a velocity of the order of the velocity of light, and that each corpuscle carries a definite and invariable charge of negative electricity.

"Inasmuch as the corpuscle always carries the same charge, whatever gas is the source of the corpuscle, some physicists hold that the corpuscle consists wholly of electricity. If this view is correct, then electricity, or at least negative electricity, must be regarded as a form of matter, and not a phenomenon of the ether, as hitherto supposed, because the corpuscle is certainly endowed with the properties of mass and inertia, the most fundamental attributes of matter. The same physicists advance the hypothesis that all forms of matter are composed wholly of electrical corpuscles, grouped in various ways, to form the chemical atom. This is an exceedingly interesting speculation, but cannot be verified or refuted until we know far more than we do now about positive electricity, and how it is associated with the negative corpuscle to form a neutral combination."

TOOL FOR TURNING WRIST PINS AND TUMBLING SHAFTS

An interesting special tool for turning wrist-pins, tumbling shafts, etc., was described in a recent issue of the *Railway Master Mechanic*. This tool is the design of Mr. John Tonge, master mechanic and master car builder of the Minneapolis & St. Paul Railroad at Minneapolis, Minn. It is used on the milling machine or lathe according to the class of work. The wrist-pins of four bar guide crossheads are turned on the milling machine with this device, as shown in the accompanying cut. Of course on a job like a crosshead or any other job having shoulders which prevent sufficient over-travel of the tool, the tool must be set twice in order to finish the surface. The device consists of a frame, *C*, split on its center line in two parts, which are solidly secured as one when in



Attachment to the Milling Machine for Turning Wrist Pins.

operation, by bolts at the center and ends. The smaller end of the frame is secured to the arm of the milling machine, and the center hole is brought in line with the machine arbor which passes through it, and the pinion, *B*, is splined to the arbor. This pinion meshes into a gear, *A*, which is made in halves and fits the larger hole in the frame. Both of these gears are grooved to fit the frame in which they work and cannot therefore leave their respective positions. The larger gear has an internal diameter large enough to clear the largest wrist-pin, and is fitted with a cutter by which the turning is done. The motion imparted to the pinion by the arbor is communicated to the gear which in turn drives the tool. When used on the lathe for turning tumbling shaft bearings a gear is screwed on the spindle in place of the faceplate and this meshes in a pinion mounted on a short splined shaft which drives the pinion *B* in the same manner as the spindle of the milling machine.

* * *

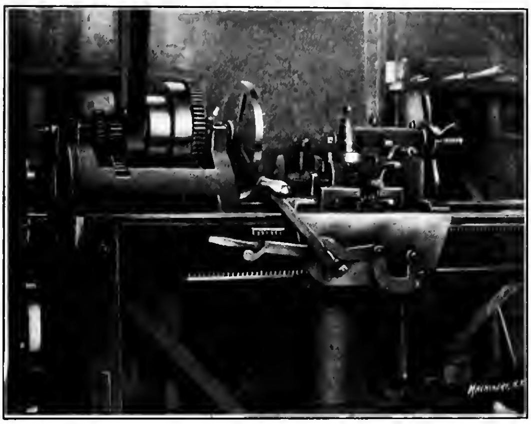
In a contributed article in the last number of MACHINERY upon "A Novel Blueprinting Apparatus" a statement was made to the effect that some of the more elaborate electric blueprinting machines were sold at a price of $500 each. While this statement is correct it is also true that machines, complete in every detail, can be had for less. J. H. Wagonhorst & Co. write us in regard to this calling attention to their electric blueprinter which although a complete and satisfactory machine, is sold for less than one-third this price. We are glad to mention this as of interest in connection with the above referred-to article.

LETTERS UPON PRACTICAL SUBJECTS.

AN ANCIENT ENGINE LATHE.

Editor MACHINERY:

Hunting with a camera will at times result in securing interesting and peculiar specimens. The machine shown in the accompanying photograph is at first sight a crude affair, but upon closer investigation will be found to have all the feeds and adjustments of any ordinary engine lathe. It is located in a country village job shop and is a strictly home-made affair. The man running it said that he wanted no better, a remark that might be loaded both ways. The bed consists of two cast-iron beams held the required distance apart by cross bars, and the whole drawn together by bolts.



An Ancient Engine Lathe.

It is supported upon wooden legs and carries two racks upon its front. The feed gear in the apron can be made to mesh with either rack, as desired, for reversing the direction of carriage travel. The feed rod is inside the bed and connects by means of a gear train with the apron gearing. One gear of the train is visible below the cross-feed handle and by substituting a gear for the cross-feed handle a power cross feed is obtained. The back gears are placed beneath the cone, weakening the headstock frame considerably. The footstock spindle bearing is adjustable on the cricket for taper turning and a leadscrew is provided at the rear. The machine is thus a screw-cutting engine lathe of novel design and is a complete tool. H. P. FAIRFIELD.

Worcester, Mass.

THE GEARED DRIVE.

Editor MACHINERY:

The article by J. C. Steen recently published in MACHINERY (December, 1905) points out the radical difference between stepped or cone pulley drive and single pulley, or geared drive, in favor of the former. It states clearly that the substitution of the cone pulley is not due to any inherent defect in the cone pulley itself. As this subject is, no doubt, of interest to many at the present time, I would make some exceptions.

It is a common sight in the shop to see a machine, cone pulley driven, doing its heaviest work up to the capacity of the machine, with the belt on one of the middle steps of the cone. This is a compromise on the part of the machinist. He has tried and found out that with the belt on the largest step of the cone he could not get enough power for a substantial cut, and he knows that the belt on the other end of the cone would be out of the question. As a matter of fact, these tools have been designed for doing the heaviest work at its maximum capacity, with the belt on the largest step of the cone, but they do not do it for two reasons: First, the largest step of the machine-cone delivers the minimum of power, equal to the amount delivered by the smallest step of the counter cone at the countershaft velocity. Secondly, notwithstanding the fact that, according to figures, the largest step of a machine cone should give the maximum pressure on the tool, or maximum torque, it does not generally do this because the smallest diameter of the counter cone is as a rule too small for the belt, with very few exceptions, and as a result of this small diameter the belt slips.

A countershaft as shown on Fig. 1 is familiar to all of us. The width of belt from the line shaft is generally the same or slightly heavier than that on the cone, and the diameter of the tight and loose pulleys is generally equal to the maximum diameter of the cone. This is another compromise on the part of the designer which does not agree with what the machine has to do. We naturally expect that a 10-inch shaft will stand a heavier cut than a 2-inch shaft, and the same could be said in reference to all kinds of work, consequently a machine should be provided with power enough to take the heaviest cut, at the limit of cutting speed, and at its full capacity. This maximum power is delivered to the machine from the smallest step of the counter-cone, measured at the countershaft speed in R. P. M. The same amount of power is delivered to the countershaft through a tight and loose pulley, measured also at the counter speed, with a slight surplus to cover friction loss in the countershaft. In consequence of this, the diameter of the tight and loose pulleys should be practically the same as the smallest diameter of the cone, and a countershaft would appear as shown in Fig. 2, but nobody would stand for such a thing, so much has "looks" to do with things mechanical.

Another consideration worth mention is the belt speed for efficiency. With reference to Fig. 3, showing counter and machine-cone connected, if the belt in the position shown (which is the most important) is speeded up satisfactorily, when placed on the other extremes of the cones it would run too fast, and, furthermore, the peripheral speed of the machine-cone in this condition might be out of the question in many instances.

If we were to consider a two-speed countershaft drive, which is sometimes necessary with the cone type drive, the difference that we have just seen would be still greater, and all the odds seem to be against the cone pulley.

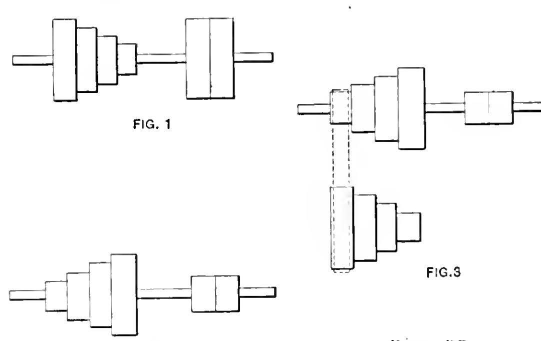


FIG. 1 FIG. 3 FIG. 2 Machinery, N.Y.

The Cone Pulley Drive for Machine Tools.

These faults appear to be inherent with the cone pulley drive and come out more prominently as the range of the speeds is increased, and more so, as the output of machine tools approaches its limit. A. M. SOSA.

Hamilton, Ohio.

MAKING BLUEPRINTS FROM TYPEWRITTEN ORIGINALS.

Editor MACHINERY:

The article in the January issue by W. H. A. on making blueprints from typewritten originals suggests to my mind the thought that perhaps the idea of printing from the carbon sheet itself is not generally known. We regularly use bond paper for making out material lists for shop use, using black "non-smut" carbon paper, reversed to print on the back side of the original copy; this in connection with black non-copying

ribbon in the machine will make very good legible copies. But it is sometimes desirable to have prints that can be readily used for notes. To get these the first carbon sheet can be used for the printing as was done in the case of the sample print sent herewith. The brush marks on the carbon paper show up on this sample rather plainer than is often the case, but still the print is legible and pencil marks will show up clearly.

The idea of printing from the carbon sheet is often of value when a customer wants a blueprint and feels slighted if a pencil sketch is sent him. All parties can be satisfied by using fresh carbon sheet in the sketch pad, and using this carbon sheet to print from. These carbon sheets require about the same care in handling as tracing paper, and by using a little care in making clear sharp lines, they will give prints of a pleasing appearance. C. J. M.

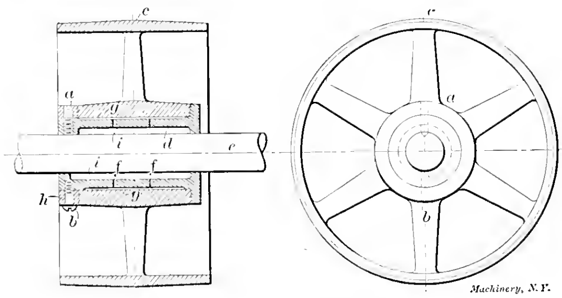
[The sample sent shows blue figures on a tinted ground, which although not white can be legibly written on with pen or pencil.—EDITOR.]

LOOSE PULLEY BEARING.

Editor MACHINERY:

I send you a blueprint showing a special loose pulley bearing which I have been using with good results, and following is a description of same:

A chamfered bushing, *d*, is mounted on the shaft and set tight with a setscrew, *a*, which also holds ring *h* in place. This ring is a collar to hold pulley from side motion. The bushing has a chamber, *i*, which connects with the outside face by small holes, *f*. The outside face is grooved toward the ends from the small holes; the holes are also connected by groove *g*. *b* is a machine screw filling a hole which communicates with chamber, *i*.



Self-lubricating Loose Pulley Bearing.

Pulley *c* runs loose on bushing *d;* the grease lubricates through holes, *f*, and is distributed along surface by means of grooves, *g*. The chamber, *i*, is filled by melting hard grease, which is poured into the chamber by removing the screw, *b*. When the bearing receives insufficient lubricant it becomes warm and more will be supplied through the openings, *f*, the grease becoming soft. I have had several of these pulley bearings running for a month at a time without refilling, and the surfaces were like glass when examined.

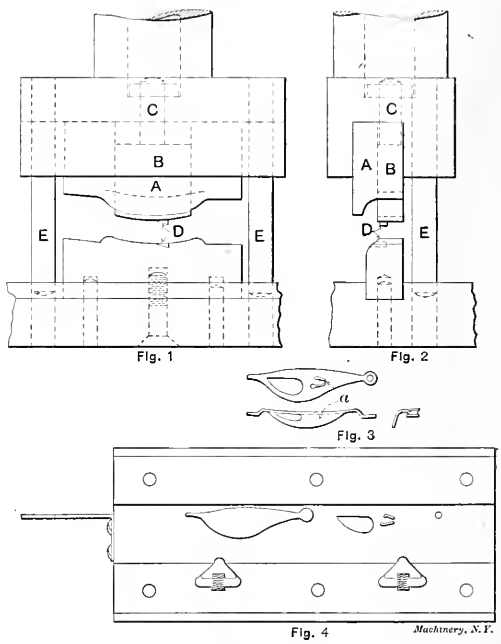
Milwaukee, Wis. C. P. BOSSERT.

DIES FOR MAKING SHUTTLE SPRINGS.

Editor MACHINERY:

The cuts, Figs. 1 and 2, show a set of dies which I made a short time ago for manufacturing the shuttle spring shown in Fig. 3. The blanking die, Fig. 4, is of the familiar "gang" or "follow" type and needs no description. The forming die, however, contains some new points in this class of tools. At least they are new to me, and I have made tools for twenty or thirty different shuttles. We had been making our forming punches of one piece of steel and the product didn't seem to come out uniformly shaped. This former, however, overcame the trouble and I learned some valuable points from it.

The forming die is made of one piece of steel worked out to the shape desired. The forming punch is made of a stationary piece, *A*, and a sliding piece, *B*, which operates within a cavity in the piece, *A*, as shown. A plunger, *C*, with a nut screwed onto the upper end works in a cavity in the head and forms a stop for the sliding piece, *B*, to which it is attached. A stiff spring in the punch head cavity is used to keep the nut against the shoulder in the cavity. This spring must be stiff enough to form and hold the shuttle spring firmly against the die while the rest of the bending is being done. This is the point we overlooked in our other formers. The stock draws away from the "sway" in the body of the spring three ways, and in the old dies these three bends were made first and there was no stock left for the "sway" or curve where the tension comes on the thread; consequently no two came alike. Another feature of this die for this particular spring is that it not only forms the spring but also cuts and forms the point marked *a*, Fig. 3.



Dies for Making Shuttle Springs.

We used heavy dowel pins, *E E*, to insure the alignment of this die. They are a good running fit in the die and are driven into the punch head, making them rigid.

When in action, the sliding piece, *B*, is the first to strike the spring blank, which is located on the forming die; it cuts the spring point *a* and forms it, at the same time putting the "sway" in the body of the spring. It holds it securely in this position by means of the spring on top of plunger *C* until the two ends and side are formed as shown. The stock used was spring steel 0.015 inch thick by ¾ inch wide and was run through the blanking die twice, cutting two rows of spring blanks one on each edge of the stock. V. H. MARCELLUS.

Dayton, Ohio.

COST ESTIMATING.

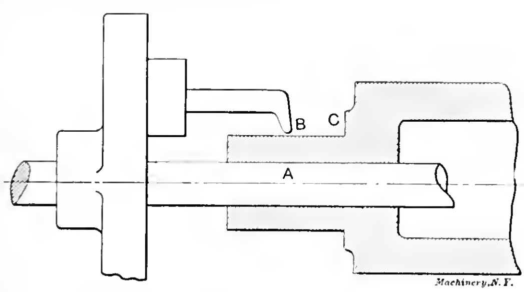
Editor MACHINERY:

Your appeal for data on the subject of cost estimating has not to my knowledge received any reply. This is not surprising. All estimating of which I have any knowledge is more or less intellectual guessing based, in general, upon observed data and perhaps on personal experience. It is mainly intuitive. Though a great amount of data must be available to form many really accurate computations of labor cost it is not the main item. By not the main item I mean not the hardest thing to learn as regards estimating. In your editorial you ask for details of how allowances are made for setting, changing, sharpening tools, etc. This is exactly the part of cost estimation that relies almost solely on intuition. As an instance a boring operation may be cited. The area tooled would be calculated out and costed, allowance made for, say, the small diameter of the boring bar allowable; when it comes to allow for setting, the time is almost always esti-

mated or guessed, which ever you please, and moreover with a man who knows the business, generally guessed about right.

Mention was made just above of calculating cost from the area of surface tooled. This is a very rational and a much used form of data. For instance, ordinary bedding down and scraping may be allowed for at 60 cents per square foot, the getting up of surface plates at 84 cents per square foot. Obviously this does not cover a great many allowances which have to be made in practice. The cut shows a trunnion for a drilling machine arm, which has to be machined in a boring machine. The boring of hole *A* may be done at ordinary speeds but the speed of machining of the trunnion *B* and the facing of *C* is to some extent limited by the size of the hole *A* which ties the diameter of the boring bar and also by the length of the trunnion which decides the overhang of the tool.

When one has made many estimates the time taken on such operations as setting and squaring up a job on the machine or setting the cams on an automatic machine operation where there can be little data that is of any use—the reasoning followed is somewhat obscure and not easily explainable. When one is new to the business, or the operation a serious one, it may be planned out and every movement allowed for; if not, the operation is mentally summed up and a time suggests itself, without direct thought of details.



Example of a Cut taken under Limiting Conditions.

A matter which would tend to minimize the value of the data, if given, is the variety in the finish of a product. Obviously the time taken is dependent to the greatest extent on the limit of error allowable in the operation and upon the trouble taken to bring the product up to a high grade. Most of the data to be used in any shop must be gathered in that shop and a lot of it is misleading if gathered elsewhere. Naturally the boring of a clearance hole will not cost as much as a small engine cylinder of the same size. But the accuracy and finish of engine cylinders vary enough to make appreciable difference in the cost of production. The accuracy of finish, too, is hard to explain. Everyone sets up his own standard. For instance, I have seen inspectors' report sheets on which the limit of error allowable for certain things were printed as zero. No doubt to the inspector's standard these points were perfect when he passed them, but his standard fortunately is not that of every one. If the machines had to be passed by someone whose perfection standard was higher it is conceivable that the cost would be greater. H. T. M.

TO CLEAN A TRACING.

Editor MACHINERY:

Tracings soon show the results of frequent use by becoming soiled, which while causing them to look bad at the same time makes it impossible to take nice clear blue prints from them. Often times changes and corrections are "penciled in" on a tracing before inking in. This leaves a confusion of penciled lines and figures. All this can be easily removd by lightly rubbing the soiled portions with a cloth which has first been saturated with benzine or gasoline. This while cleaning the tracing thoroughly will not affect the ink and makes the tracing look almost like new.

After making erasures on a tracing I always take a talc pencil, or soapstone as it is some times called, and rub over tracing cloth at place of erasure. This gives the cloth a new surface which will take ink nicely and will not catch the dirt.

Sharon, Pa. R. F. KIEFER.

TWO USEFUL FORMULAS.

Editor MACHINERY:

I give below a couple of rules which I have found useful. The first is for finding the weight per running foot of pipes, tubes and columns, and is expressed in the following formula:

$$W = K\ (D^2 - d^2)$$

in which

D = outside diameter.

d = inside diameter.

W = weight per running foot.

K for wrought iron = 2.64

K for cast iron = 2.45

K for brass = 2.82

K for copper = 3.03

K for lead = 3.86

The constant for cast iron (2.45) is based on cast iron weighing 0.26 pounds per cubic inch, or 450 pounds per cubic foot, it is best to add 10 per cent to these figures in order to provide for overweight in the foundry.

The second rule or formula is to find the number of teeth in a pair of gears in which the distance between centers, ratio and pitch are given:

$$N = \frac{C\ 2\ R\ P}{R + R_1}$$

$$n = \frac{C\ 2\ R_1\ P}{R + R_1}$$

in which

C = center to center of gears.

R and R_1 = terms of the ratio (substitute highest term for R.)

P = diametral pitch.

N = number of teeth in large gear.

n = number of teeth in small gear. ALEX. C. LABAR.

Chattanooga, Tenn.

A SELF-CENTERING CENTER PUNCH.

Editor MACHINERY:

Under the above title in the December issue of MACHINERY is found described and illustrated a neat and handy tool for the purpose intended, but I fail to appreciate the necessity of making such an elaborate affair and wish to submit the following as a substitute. Although there is nothing new or novel about it, I believe it has some superior features.

Fig. 1 shows two forms of the style of punch to use for the purpose referred to in the article mentioned, *i. e.*, transferring the centers of a number of holes already drilled onto the surface of another plate or flange.

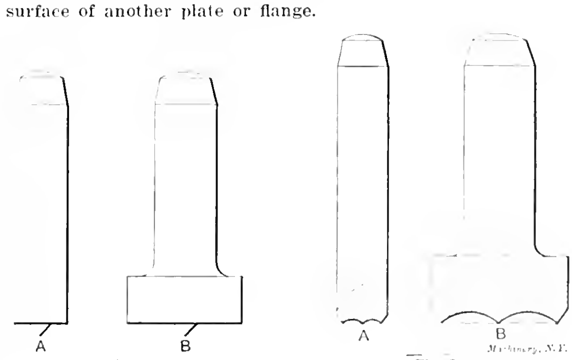


Fig. 1. Fig. 2

Two Forms of Self-centering Center Punches.

Form A is suitable for the smaller sizes. Form B should be used where the holes through which the punch is to be used are so large as to make the mass of a straight punch objectionable. Fig. 2 shows a style of punch suitable to mark through free holes for tap drilling on the corresponding plate or flange where cap screws are to be used to fasten the two pieces together. The impression from these punches furnishes an outer line or circle to drill to.

The advantages of these punches over the one referred to in the previous article are that the labor upon the complete punch is no more than upon any one piece of the other;

there are no moving parts to become stuck by dirt or grit, and no spring to bother or break. I will suggest another method for this class of work which, if practical, will do away with any punching whatever. That is, clamp the piece first drilled upon the surface to which it is to be bolted and if the holes in the second piece are to be of the same size as those in the first piece, simply drill through the first piece into the second, using the pieces first drilled as a guide. If however, the holes in the second piece are to be tapped, "spot drill" through the first piece into the second, use a drill of the same size as that used for the first piece but feed it through the first piece into the second only the depth of its full cutting edge, then remove this drill from the socket and replace it with one of required diameter for tapping. Enter it into the "spots" made by the larger drill and drill through or to the required depth. CLAY-BEAN.

RATCHET STOP HANDLE FOR MILLING MACHINE VISES.

Editor MACHINERY:

The drawings reproduced herewith show a ratchet stop handle for milling machine vises, and its parts. The object sought in this handle is the avoidance of springing the pieces to be milled and the securing of a uniform pressure on each piece when many are to be milled.

to see the screws of vises and other clamping devices in a badly worn and strained condition simply because of over-pressure caused by careless operators. We would suggest that in the device illustrated the matter of spring adjustment be taken entirely out of the hands of the operator and that the adjusting nut *C* be pinned to the plunger *B* rather than secured by a lock nut. The average operator would no sooner find out that the handle slips after a certain pressure is applied than he would set up the nuts sufficiently to make a practically solid handle, if not restrained.—EDITOR.]

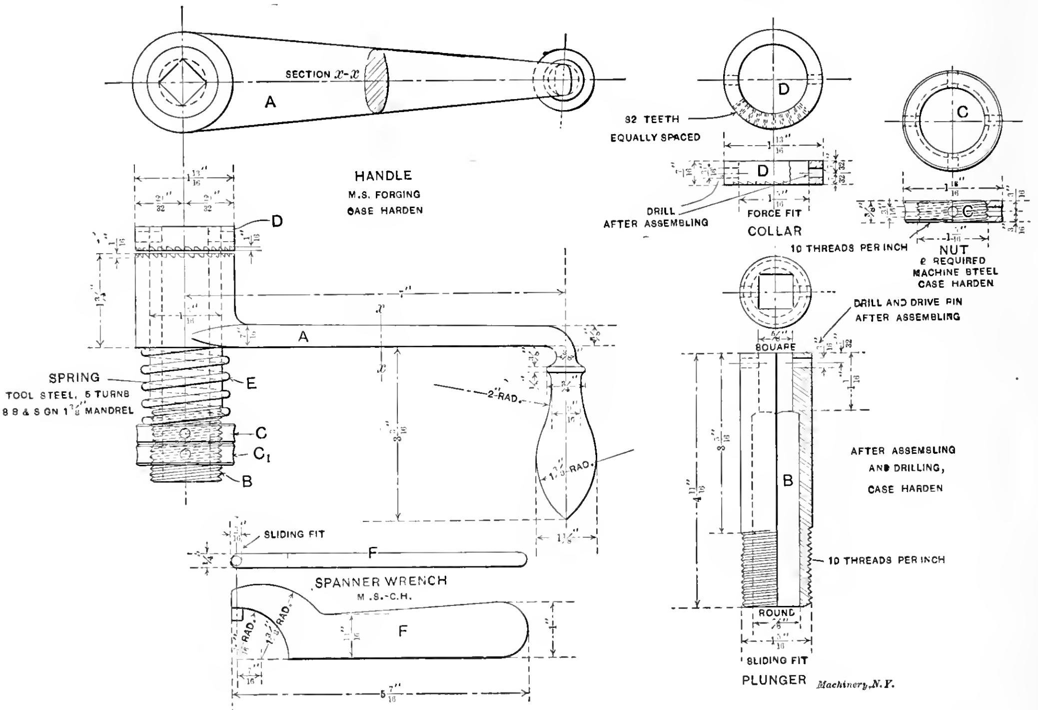
RULES FOR FINDING THE CAPACITY OF STEAM HAMMERS, AND THE HORSE POWER REQUIRED FOR OPERATION.

Editor MACHINERY:

I beg to call your attention to some simple rules regarding steam hammer practice, which may be of value to some of your readers. The first of these rules gives the horse power required to run a hammer of any size and may be expressed as follows:

Divide the rated capacity of the hammer, in pounds, by 100, and the quotient will be the horse power required to run the hammer constantly.

This rule is also applicable in cases where the hammer is not run constantly, by estimating the amount of time the hammer



Details of Ratchet Stop Handle for the Milling Machine Vise.

The construction is plainly shown in the cut and little description is necessary. A plunger (so-called) *B* is threaded on one end to receive the nuts *C* for regulating the pressure of the spring *E*. The plunger is broached out at one end to fit the square on the milling machine vise screw and is free to slide within the handle *A*. The collar *D* is pinned fast to *B*, and one side is milled with ratchet teeth corresponding to those milled on the face of the handle bars. In use, when the desired degree of pressure has been developed on the screw, the teeth slide past each other, thus preventing over-pressure. Turning the handle in the opposite direction loosens the vise screw, the teeth then acting positively. The teeth may be cut at an angle of 30 degrees, or less.

Newark, N. J. HENRY F. HOWARD.

[The idea embodied in this handle is one that can be profitably used on other tools where repetition work is being done by comparatively raw labor. Nothing is more common than

is idle each hour and making allowance therefor. But it will be noted that in case the hammer is not run constantly, or nearly so, and the horse power is correspondingly reduced, sufficient steam storage space must be provided in the boiler to prevent the steam pressure being drawn down much faster than it is made during the working period.

The second rule deals with the estimate of the proper size of hammer to be used in working iron and steel of any desired cross-sectional area. The rule is as follows:

Multiply the greatest cross section desired to be worked in the hammer by 80, if of steel, or 60, if of iron, and the product will be rated value of the hammer required in pounds.

This rule will give a hammer for safely working material of the size specified, at one heat. No doubt many of the readers are doing what we frequently do, that is, work billets which exceed in size that which would be allowable if the rule was always followed. But, in general, it will be found that

it gives what will probably prove to be the most economical practice in working steel and iron under a steam hammer. To make these rules clear I append an example: What size hammer will it require to work a 4 by 4 inch square steel billet, and how much horse power will it require?

Solution: $4 \times 4 = 16$; $16 \times 80 = 1{,}280$. Size of hammer required 1,280 pounds. $1{,}280 \div 100 = 12.8$, or boiler horse power required.

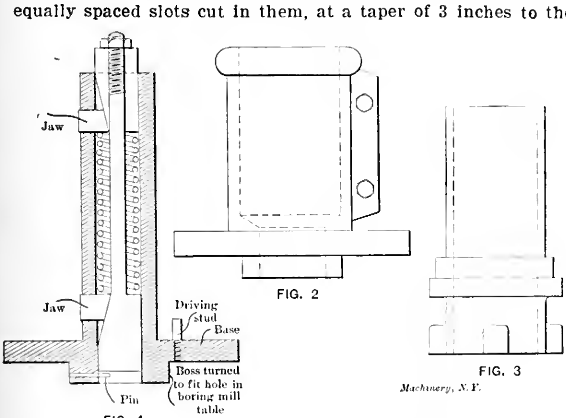
In any event these rules will be found perfectly safe to follow in making up estimates and they are used by at least one of the largest steam hammer builders in this country.

Richmond, Va. L. N. Gillis.

BORING MILL FIXTURES FOR TURNING AND BORING STEAM PUMP LINERS.

Editor Machinery:

Figs. 1 and 2 of the accompanying cuts represent fixtures used on a boring mill for turning and boring liners for steam pumps, and Fig. 3 is the liner. Contrary to the usual custom the liner is first turned and after bored. Fig. 1 is the chuck on which the liner is turned; the body of the chuck is made of cast iron. The boss on the bottom is turned to fit the hole in the boring mill table and the base is slotted to receive clamping bolts. The jaws are six in number, three at the top, and three at the bottom, and are forced out by the two sliding blocks in the bore of the fixture, being drawn together by the nut at the top. Each of these sliding blocks has three equally spaced slots cut in them, at a taper of 3 inches to the



Fixtures for Chucking Pump Liners in the Boring Mill.

foot, which move the jaws out. The coil spring forces the blocks apart upon the tightening nut being unscrewed, and releases the work. A pin is driven in the bottom of the bore, to act as a stop for the bottom block. The work is driven by a stud shown in the base.

After the liner is turned the fixture shown in Fig. 2 replaces that shown in Fig. 1. This fixture is bored and split to fit the turned portion of the liner, which is tightened in place by the two clamping bolts, and is then bored and reamed.

C. P. L.

RECEIPT FOR MAKING A FIRST-CLASS MACHINIST.

Editor Machinery:

First, take a liberal amount of conceptive brains, possessed by an intelligent boy of 18 years of age; second, add to these six months experience in a large jobbing machine shop as "roustabout"; third, add one-and-a-half years experience on machine operation; fourth, with a club, crowbar, or sledge hammer, knock all of the conceit out of the boy; fifth, add one-and-a-half years experience in erecting work; sixth, add to this combination four parts of good horse sense, three parts of confidence, four parts of executive ability, three parts of endurance, one part nerve, one part attentiveness; seventh; stir these ingredients together well, in large bowl of sobriety with a club known as a year's experience at "roughing it"; eighth, smooth down with some fine emery cloth, and serve immediately.

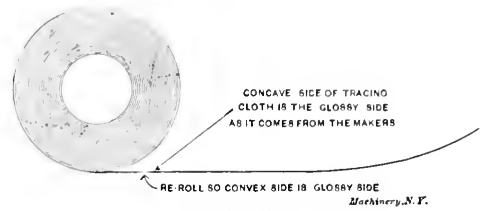
I will guarantee that in nine cases out of every ten this receipt will produce a first-class all-around machinist.

Pearl River, N. Y. H. E. Wood.

RE-ROLLING TRACING CLOTH TO PREVENT CURLING.

Editor Machinery:

Probably all, or nearly all, draftsmen are troubled with tracings curling up at the edges when filed away in drawers. It seems almost impossible to make them lie flat and when put into the printing frame the edges get folded down and make bad looking edges on the prints. Not very many draftsmen like to use the dull side of the tracing cloth, though drawings made on this side will keep flat much better than when the glazed side is used. Some time ago I came to the



To Prevent Tracings from Curling.

conclusion that this was due to the fact that when manufactured the cloth is rolled with the concave side the glossy side as shown in cut, which of course causes it to curl. With a view to overcoming this I took a roll of tracing cloth and re-rolled it, putting the dull side in. This roll I left lying away for a month or more before using it and found that there was a great improvement and that the drawings made on glossy side were curled down at the edges rather than up. If one should make some sort of a rewinding device for the purpose I think it would be found to be worth the trouble.

W. E. M.

CHANGING GEAR RATIOS.

Editor Machinery:

In the October issue of Machinery Mr. Josselyn explains a method of changing gear ratios when the number of teeth and the center distance are fixed. While I do not wish to criticise his method, I would like to suggest another, and what I think a more simple way of doing it. Taking Mr. Josselyn's first example, assume a driving shaft running 100 R. P. M., and that it is desired to revolve the driven shaft 60 R. P. M.; the total number of teeth to be utilized is 120. $60/100 = 3/5$, as 60 is to 100, so 3 is to 5. We have 120 teeth to be divided in the proportion of 3 to 5. $5 + 3 = 8$; $120 \div 8 = 15$. Multiplying both numerator and denominator of 3/5 by 15 we have 45/75, 45 being the driver.

Taking the second example, assume a driving shaft running with 100 R. P. M. and that it is desired to run the driven shaft 150 R. P. M. Total number of teeth to be utilized is 120. $100/150 = 2/3$. $2 + 3 = 5$; $120 \div 5 = 24$. Multiplying both numerator and denominator of 2/3 by 24 we have 48/72.

We readily understand that the large gear should go on the shaft which we want to run the slowest in each case.

Cleveland, Ohio. C. M. McElhany.

* * *

The first concrete skyscraper is the Ingalls Building, of Cincinnati, Ohio. It is sixteen stories, rising to a height of 210 feet from the sidewalk. It should be noted that this building differs from the usual form of skyscraper, having a steel frame and brick or granite skin, with the skin entirely supported by the steel frame. The Ingalls Building is a concrete box, as it were, having eight-inch walls of reinforced concrete, being entirely devoid of the usual I-beams, Z-bars, angle-irons, etc., characteristic of the steel frame skyscraper. The Ransome system of reinforcement, consisting of cold-twisted square bars is used throughout. The fact that buildings sixteen stories high can be successfully constructed of concrete seems to answer any questions as to whether concrete is a practicable building material. It would seem, in view of the scarcity of lumber and its rapidly-increasing price, that concrete ere long must be an almost universal material for building construction as well as engineering operations generally where masonry or steel have had the call in the past.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO TREAT FOREIGN MATTER IN THE EYE.

At night when you get home and find you have a piece of iron or other foreign matter in the eye that irritates it, and you have no way of removing it until morning, take a raw Irish potato, grate it, and use as a poultice on the eye; it will ease the eye so you can sleep, and if it does not draw the piece out, you can have it removed next morning as the eye will not be inflamed, unless it is a very bad piece. I have used this frequently, and it is the best thing I have ever tried. C. P. L.

TO PREPARE EMERY FOR LAPPING GAGES.

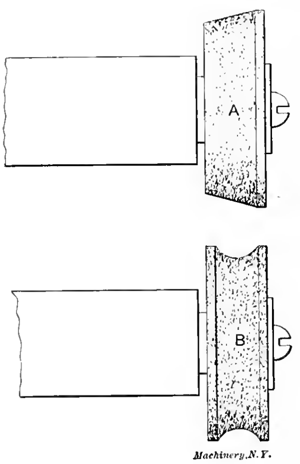
To prepare emery for lapping screw gages, plugs, etc., fill a half-pint bottle with machine oil and flour emery in the proportions of about 7 parts of oil to 1 part of emery by bulk. Mix thoroughly and let stand for twenty minutes during which time the heavier particles of emery will settle to the bottom. Now take the bottle and carefully pour off about one-half the contents without disturbing the settlings. The portion poured off contains only the finest emery and will never scratch the work.

For surface lapping put some flour emery in a linen bag and tie up closely with a string. Dust out the emery by striking the bag against the surface plate; use turpentine for rough lapping and the dry surface plate for finishing.

New Haven, Conn. A. L. Monrad.

DRESSING GRINDING WHEELS TO PREVENT GLAZING.

In circular grinding, the wheel is often beveled as at *A* in order to present less grinding surface to the work. This lessens the tendency to glaze, and in internal grinding allows the wheel to pass through the piece being ground with only a small clearance between the work and the chuck.



However, where there is room for the whole wheel to over-travel the work, the wheel should be dressed as at *B*. Not only does this form prevent glazing, as the form *A*, but it has the advantage of two cutting edges, and the wheel wears less rapidly.

O. L. Lewis.

Indianapolis, Ind.

[As an expedient this practice may be good, but it is better to select a grade and width of wheel that can be used with the full surface working, both on the score of economy of wheel material and time saved in dressing.—Editor.]

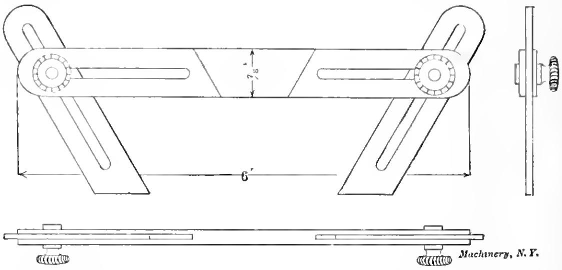
TO CASEHARDEN LOCALLY.

In casehardening certain articles it is sometimes necessary, or desirable, to leave spots or sections in the original soft uncarbonized condition while the remainder is carbonized and hardened. This may be effected by first covering the parts to be hardened with a protecting coat of japan, and allowing it to dry. Then put the piece in an electroplating bath and deposit a heavy coat of nickel over the parts not protected by the japan. The piece thus prepared may be treated in the usual manner in casehardening. The coat of nickel prevents the metal beneath being carbonized so, of course, it does not harden when dipped in the bath. Bristol.

[A plating of copper answers the same purpose as nickel and is often used. A simpler plan, where the shape of the piece permits, is to protect it from the action of the carbonizing material with an iron pipe or plate closely fitted or luted with clay. Another scheme is to machine the parts wanted soft after carbonizing but before hardening, of course. By this procedure the carbonized material is removed where the metal is desired soft and when heated and dipped these parts do not harden.—Editor.]

A DOUBLE-ENDED BEVEL.

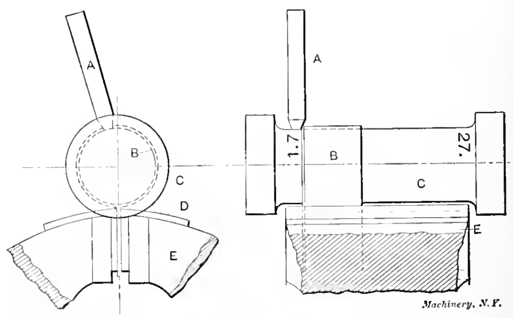
The sketch here shown is a very common-looking tool, but I find it a very useful one. It was especially made for getting the bevel on dovetails for pole piece dies, and I have also used it for several other purposes; when you get one you will wonder how you ever got on without it. It is made of sheet steel 0.070 inch thick, which has been cleaned up on a surface grinder. It is very simple in construction, consisting of two



flat pieces the full length and one center piece, the shape shown by the dotted lines. When finished it is about 3-16 inch thick, which just gives a nice surface to keep it level on the work. It saves the trouble of making a gage, as it can be set exact and then the work can be shaped out right down to size. The screws are made with a tongue underneath the head, by filing two flats, to prevent turning when being tightened. Any one who goes to the trouble of making one of these bevels will be well repaid. Barney.

USE OF A TEMPLET FOR STAMPING WITH STEEL LETTERS.

Having had considerable stamping to do recently with steel letters it was up to me to find a way to do it neatly and get all the letters in line. I found out after some experience that if I made a templet of a thin metal such as tin or sheet brass and clamped it to the work, it was an easy matter to do a good job by setting the letters to the templet. The accompanying sketch illustrates the method of using the templet on a cylindrical piece, say, a standard gage, *C*. The templet



is clamped around the body and held for convenience in the jaws of the vise, *E*. The working edge of the templet is beveled to approximately the same angle as the tapered part of the steel letter *A*. Not all steel letters are square with the body but the use of the templet largely rectifies this defect for the reason that the tapered part is usually made square with the face of the letter. Foster Hillix.

Purdue University, Lafayette, Ind.

* * *

Don't file out a hole and attempt to put a shaft in it without making sure that no broken file beards are left sticking inside of the hole.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

149. LUBRICANT FOR LATHE CENTERS.

An excellent lubricant for lathe centers is made by using 1 part graphite and 4 parts tallow thoroughly mixed.

Rock Falls, Ill. E. C. NOBLE.

150. SOLDERING SOLUTION FOR STEEL THAT WILL NOT RUST THE WORK.

A soldering solution for steel that will not rust or blacken the work is made of 6 ounces alcohol, 2 ounces glycerine and 1 ounce oxide of zinc. A. L. MONRAD.

New Haven, Conn.

151. TO BRASS SMALL ARTICLES.

To brass small articles of iron or steel drop them into a quart of water and ½ ounce each of sulphate of copper and protochloride of tin. Stir the articles in this solution until desired color is obtained. R. M.

152. CEMENT FOR STEAM AND WATER PIPES.

A good cement for joints on steam or water pipes is made as follows: 10 pounds fine yellow ochre; 4 pounds ground litharge; 4 pounds paris white (whiting), and ½ pound of hemp cut up fine. Mix together thoroughly with linseed oil to about the consistency of putty. R. M.

153. TO REMOVE HARD GREASE, PAINT, ETC., FROM MACHINERY.

To remove grease, paint, etc., from machinery add half a pound of caustic soda to two gallons of water and boil the parts to be cleaned in the fluid. It is possible to use it several times before its strength is exhausted. F. PAVLIK, JR.

Winnetka, Ill.

154. ALLOY FOR PATTERN LETTERS AND FIGURES.

A good alloy for casting pattern letters and figures and similar small parts in brass, iron or plaster molds is made of lead, 80 parts, and antimony, 20 parts. A better alloy will be lead, 70 parts; antimony and bismuth, each 15 parts. To insure perfect work the molds should be quite hot by placing them over a Bunsen burner. The writer has had thousands of pattern letters and figures made in this manner.

Neponset, Mass. OSCAR E. PERRIGO.

155. COPPER COATING SOLUTION.

A copper coating solution for use when laying out work on iron or steel which I have found more satisfactory than the ordinary blue vitriol is a mixture of saturated solution of zinc chloride with a very little copper sulphate added, say a half-dozen drops of copper sulphate to a spoonful of zinc chloride solution. When a piece of steel is rubbed with waste moistened in this solution it produces a bright copper surface that does not easily rub off. MILTON BURGESS.

Cleveland, Ohio.

156. TO CLARIFY SHELLAC VARNISH.

Even with the best of care the pattern maker will find his shellac leaving dirty streaks on the pattern from various impurities held in suspension in the varnish. These may be entirely precipitated by the gradual addition of some crystals of oxalic acid, stirring the varnish to aid their solution, and then setting it aside over night to permit the impurities to settle. No more acid should be used than is really necessary.

Neponset, Mass. OSCAR E. PERRIGO.

157. CLAYING MIXTURE FOR FORGES.

Running as we do about twenty-four fires in our smith shop, we have experienced some little difficulty in securing a satisfactory claying mixture with which to clay the forges. This difficulty arises, in part, from the fact that the forges are used by inexperienced individuals. After repeated trials with various mixtures recommended, we experimented until we finally hit upon the eminently satisfactory one given in the following: 20 parts, fire clay; 20 parts, cast iron turnings; 1 part, common salt; ½ part, sal ammoniac; all by measure.

The materials should be thoroughly mixed dry and then wet down to the consistency of common mortar, constantly stirring the mass as the wetting proceeds. A rough mold shaped to fit the tuyere opening, a trowel and a few minutes' time are all that are needed to complete the successful claying of the forge. This mixture dries hard and when glazed by the fire will outlast anything ever tried.

St. Louis, Mo. STANLEY H. MOORE.

158. ETCHING FLUID FOR STEEL.

The following receipt for etching fluid for steel, was highly recommended to me, and I have tried it in comparison with another fluid on hardened steel. I found it will make very neat and sharply defined lines, and does the work very quickly:

Nitric acid, 60 parts; water, 120 parts; alcohol, 200 parts, and copper nitrate, 8 parts. Keep in a bottle having glass stopper. To use the fluid, cover the surface to be marked with a thin even coat of wax and mark the lines with a machinist's scriber. Wrap a bit of clean waste around the end of the scriber or a stick, and dipping same in the fluid, apply it to the marked surface. In a few minutes the wax may be scraped off, when fine lines will appear where the scriber marked the wax. The drippings from a lighted wax candle can be used for the coating, and this may be evenly spread with a knife heated in the candle flame. W. S. LEONARD.

Lansing, Mich.

159. PRACTICAL FORMULA FOR SENSITIZING BLUE-PRINT PAPER.

To prepare the blueprint solutions, dissolve 3¾ ounces of ammonia citrate of iron, in 18 ounces of water, and put in a bottle. Then dissolve 2⅝ ounces of red prussiate of potash in 18 ounces of water, and put in another bottle. When ready to prepare the paper, have the sheets piled one on top of the other, coating but one at a time. Darken the room, and light a ruby lamp. Now, mix thoroughly equal parts of both solutions and apply the mixture with a sponge in long parallel sweeps, keeping the application as even as possible. Hang the paper in the dark room to dry and keep it dark until used. Any of the mixture left, from sensitizing the paper, should be thrown away, as it deteriorates rapidly.

Often, in making blueprints by sunlight, the exposure is too long, and when the frame is opened the white lines of the print are faint or obscure. Usually these prints are relegated to the waste basket; but if, after being washed as usual, they are sponged with a weak solution of chloride of iron, their reclamation is almost certain. When the lines reappear, the print should be thoroughly rinsed in clear water.

Often a drawing, from which prints have already been made, requires changing. The blueprints then on hand are worthless, requiring more time to correct than it would take to make a new print. An economical way of using the worthless prints is to cancel the drawing already thereon, sensitize the reverse side, and use the paper again.

Youngstown, Ohio. JULIAN DAY PAGE.

160. WHITE AND RED SOLUTIONS FOR WRITING ON BLUE PRINTS.

After reading your "How and Why" column in the December issue I thought perhaps you might be interested in the way I make a solution for marking white lines on blue prints. I add to a small bottle of water enough washing soda to make a clear white line, then I add enough gum arabic to it to prevent spreading and making ragged lines. To make red lines I dip the pen in red ink and then add a little of the solution by means of the quill. ED. H. RUMDF.

Cleveland, O.

* * *

Mr. A. L. De Leeuw, formerly mechanical engineer of the Niles Tool Works and a contributor to MACHINERY has opened an office in Hamilton, Ohio, for consulting practice. The work he undertakes is the planning of new shops and additions; modernizing of shops; the application of motors to machine tools; designing of special machinery; and the making of standard drawings for such concerns as cannot afford to employ capable talent the year round.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

13. C. G. H.—I should like to present the following questions to the readers of MACHINERY:

How much pressure is required to punch a 1-inch hole through a ½-inch steel plate?

Does the pressure vary in direct proportion to the area of the hole and the thickness of the plate

If this is true, should one take the area of the rectangle for a rectangular hole or the area of a circle having a circumference equal to the sum of the sides of the rectangle?

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14. H. A. S.—I have run into a rather difficult problem which will best be explained by the following diagram, Fig. 1. There are three cylinders, as shown, two of them 1 inch in diameter and the other one ½ inch in diameter with center distances as given. The problem is to find the diameter and location of a roll which will just touch these three cylinders.

A.—The solution of this problem may be followed by referring to the diagram shown in Fig. 2. This shows the location of the four circles in question together with the additional lines needed to complete the proof. We know from the information given that

$$ab = 1.5$$
$$bc = 1.125$$
$$ac = 1.25$$
$$r_1 = 0.5$$
$$r_2 = 0.25$$

also since the two larger cylinders are of the same size we know that

$$ao = bo = R + r_1$$

It will thus be seen that triangle aob is an isosceles triangle with sides ao and bo equal; cd is drawn perpendicular to ab.

$$\therefore ae = be = 1.5 \div 2 = 0.75.$$

From a well-known formula for oblique angle triangles we have the following expression:

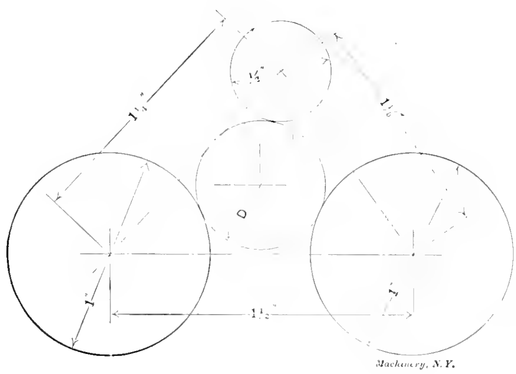


Fig. 1.

$$ab : ac + bc = ac - bc : ad - bd. \qquad (1)$$

Since $ae = be$, it will be evident that $ad - bd = 2de$. Substituting this value in equation (1) we have

$$ab : ac + bc = ac - bc : 2de$$

solving this for de, the unknown quantity, we have

$$de = \frac{(ac + bc)(ac - bc)}{2ab}$$

$$\text{and } de = fo = 0.09895$$

fo being perpendicular to cd. To find the unknown radius R, we proceed as follows:

$$ad = ae + de = 0.75 + 0.09895 = 0.84895$$
$$cd = \sqrt{ac^2 - ad^2} = 0.91747$$

Since aco is a right angle triangle, we know that

$$co = \sqrt{ao^2 - ae^2} \qquad (2)$$

cof being likewise a right angle triangle we know that

$$cf = \sqrt{co^2 - fo^2}, \text{ then}$$
$$eo = df = cd - cf = cd - \sqrt{co^2 - fo^2} \qquad (3)$$
$$\therefore \sqrt{ao^2 - ae^2} = cd - \sqrt{co^2 - fo^2} \quad (2 \text{ and } 3)$$

Referring again to the diagram, Fig. 2, it will be seen that ao and co are each composed of two parts, one of which is unknown, the unknown quantity being R, the radius of the unknown circle; substituting in this last equation $r_1 + R$ for ao and $r_2 + R$ for co, we have the following:

$$\sqrt{(r_1 + R)^2 - ae^2} = cd - \sqrt{(r_2 + R)^2 - fo^2}$$

This equation contains but one unknown quantity, R. Solving for this we find that $R = 0.3272$, thus making the diameter of the circle $2 \times 0.3272 = 0.6544$ inch.

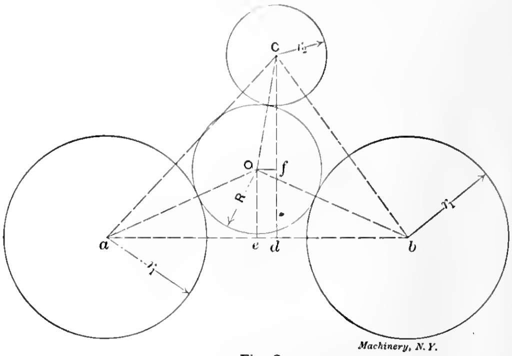


Fig. 2.

Since we can now determine the value of ao, which equals $r_1 + R$, we can solve equation (2) for eo. This gives us $eo = 0.3489$ inch, and thus locates the center of the tangent circle.

This is a specific case of the general problem which requires the location of a central circle tangent to three known circles of definite location. This particular case is comparatively easy of solution owing to the fact that two of the known circles have the same diameter. The general problem where the known circles are all of different diameters is a puzzler for the draftsman who is unfortunate enough to meet with it. So far as we are aware, no accurate and simple solution has been proposed.

* * *

TO BIND DATA SHEET NO. 48.

Editor MACHINERY:

In questions and answers appearing in the December issue C. E. G. says a number of subscribers would be pleased if you would explain why data sheet No. 48 was made an odd size. Tell C. E. G. to cut off the side, bottom and center margins, leaving the top margin, thus making two equal parts of the sheet; then cut off the top margins for one-half their lengths, leaving the left half in each case. Punch holes in the usual way in this half margin that is left and you have two data sheets that are four times the regular size, which by folding twice, will be the same as the regular size; they can be easily unfolded for reference when bound in book form with the other sheets. H. E. TWOMLEY.

Detroit, Mich.

* * *

Frederick T. Towne, general superintendent of the Yale & Towne Mfg. Co., Stamford, Conn., died on February 4th from Bright's disease. He was born in 1872, graduated from the Massachusetts Institute of Technology and took a course in practical work in the different departments of the Yale & Towne plant. He was made superintendent of the works in 1900 and had been singularly successful in his management, had taken a deep interest in industrial betterment, especially in connection with the Stamford factory, and in educational matters, having organized classes of employees to receive instruction in mechanical subjects. He was a member of the American Society of Mechanical Engineers, president of the Stamford Manufacturers' Association, and had become intimately associated in many ways with the industrial and social life of his home city. Upon the afternoon of his burial most of the local manufacturing establishments were closed as a manifestation of the high regard in which he was held.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

LINCOLN VARIABLE-SPEED MOTOR.

The Lincoln Electric Mfg. Co., Cleveland, Ohio, have designed a line of variable-speed motors especially adapted for direct connection to machine tools. As may be seen from the half-tone, Fig. 1, and the line cut, Fig. 2, the armature may be moved longitudinally by means of the hand wheel at the pulley end of the machine. This hand wheel through the nut *B* operates the lever *E*, which in turn moves the journal and thrust bearings in box *G* in or out according to the direction in which the wheel is turned. To counterbalance the magnetic pull of the field spring *O* is provided.

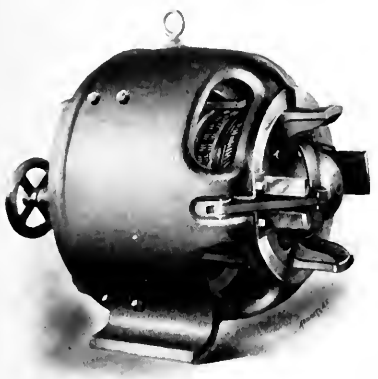


Fig. 1. Lincoln Variable-speed Motor.

When, as is shown in Fig. 1, the armature is drawn to its extreme outward position, it is very largely removed from the influence of the magnetic flux through the poles, thus greatly weakening the field. In accordance with the well-known law governing the action of electric motors, this weakening necessitates an increase in speed of the armature to generate a sufficient counter electro-motive force to balance the current supplied. To more rapidly weaken the strength of the field, the armature is made slightly tapering with the smaller end at the rear so that the air gap is increased as it is withdrawn from beneath the poles, thus still further increasing the resistance of the magnetic circuit and still further increasing the speed of the motor.

To counterbalance the distortion of the magnetic flux a special commutating field is provided within whose influence the armature comes when it is withdrawn for the higher speeds. As may be seen from the half-tone in Fig. 1 this field is in the shape of a horn or projection extending outwardly

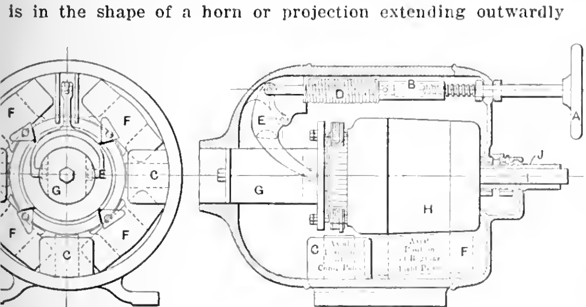


Fig. 2. Section of Lincoln Motor, showing Armature Shifting Mechanism.

from the pole pieces. This extended pole furnishes a field of constant strength at the point where commutation takes place, so that no matter what the distortion of the flux would normally be at the time when a commutator bar is passing under the brush it is working under practically constant conditions. This, of course, is practicable, owing to the fact that the field current is invariable, whatever the speed at which the motor is running. In the design shown in the line drawing, Fig. 2, the commutating pole is arranged somewhat differently. Here supplementary field coils and pole pieces are provided. The current in these coils is constant like that in the main field, the armature being more or less under the influence of these coils as it recedes from or returns to the main magnetic field. A great advantage of this design lies in the fact that the combination of decrease in effective pole area, together with the increase in length of air gap, makes a wide variation of speed possible for a simple motor connected in an ordinary two-wire, single-voltage direct-current circuit. The horse power of the motor is uniform, the torque varying inversely with the number of revolutions per minute at which the armature revolves. The gradations of speed are infinitely small, since the changes are made by a hand wheel and screw which may be placed in any position whatever within the range provided by the machine,

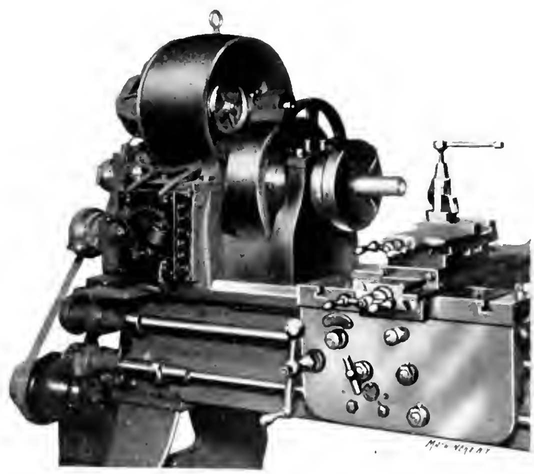


Fig. 3. Lincoln Motor applied to Engine Lathe.

the number of speeds not being dependent on the number of steps provided in the rheostat resistance, as is usual with the ordinary variable-speed motor.

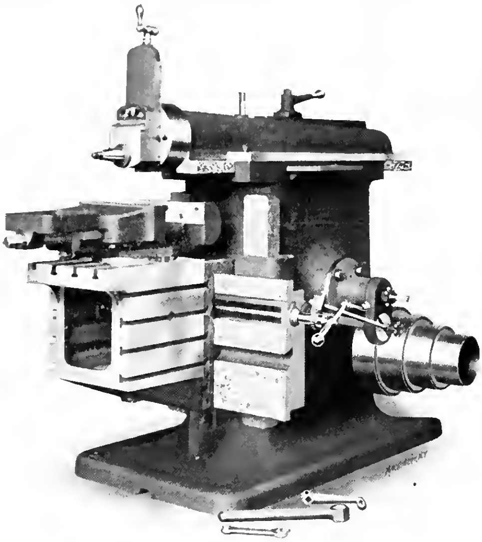
In mechanical construction the machine is designed to meet the highest standards of electrical machinery building. The bearings are self-oiling with reservoirs of ample capacity for supplying the bearings for a long time. The armature and field coil insulations are tested with a 300-volt alternating current before leaving the factory. Since all the speeds are obtained with one voltage from an ordinary two-wire circuit the electrical construction of the machine is of the simplest, being of the 4-pole shunt-wound type, requiring no other auxiliary apparatus than an ordinary no voltage release starting box.

Fig. 3 shows the application of the motor to the head stock of a lathe; it will be noticed that the hand wheel is within easy reach of the operator. The instrument under the motor is a starting box only, and is not used for varying the speed.

The line as at present built consists of three sizes of frames giving from 1 to 20 horse power at from 125 to 2,000 revolutions per minute depending on the electrical design of the windings. The speed range may be anywhere from 2½ to 1 up to 10 to 1 as desired by the purchaser. The motors will be wound for 110, 220 or 500 volts direct current. The makers undertake to provide the machine with an efficiency equal to that attained by the best of other makes of variable-speed motors, and will furnish prospective customers with results of tests of any size under consideration; where large installations are planned, they will make comparative tests with other variable-speed motors.

SPRINGFIELD HEAVY DUTY BACK GEARED CRANK SHAPER.

The accompanying half-tone illustrates a shaper specially designed to meet severe service conditions. Massive proportions, ease of manipulation, great driving power and large capacities are the requirements considered in the design of this machine by its builders, the Springfield Machine Tool Co., Springfield, Ohio. The column is internally ribbed throughout, with bored holes for all journal boxes, and has long bearing surfaces for the ram, extended at both the front and back. The ways for the cross rail are unusually deep and extend from top to bottom of the column. The base is large and runs out in front with a raised lip around its edge to retain oil and chips. The ram is internally ribbed in such a way as to afford its greatest strength to bending when it is extended the maximum distance from its bearing. The tool head can be swiveled to any angle and securely locked by two bolts. The feed screw is provided with a micrometer collar reading to thousandths of an inch and can also be furnished with automatic down and angular feed if desired.



The Springfield 25-inch Crank Shaper.

The cross rail is of box section and is rendered self aligning by having one of the ways on the column provided with an angular back face to which the gib fits. By tightening the screws in this gib the rail will always be square. The telescopic elevating screw has a ball thrust bearing. The cross feed screw has a micrometer collar, reading to thousandths of an inch. The box table has large working surfaces on three sides, to any of which work may be clamped. The way in which this table is fastened to the cross slide is somewhat unusual, since instead of securing it by planer bolts in T-slots in the cross slide, three large studs are used which pass entirely through the top of the cross slide above the bearing of the cross rail, the table being clamped by nuts on these studs. This relieves the cast iron of tensile strain, transferring this entirely to the steel studs. The necessity for a support under the table is avoided through the enlargement of the ways on the column, the deeper cross rail, the method of fastening the box table, and the way in which this latter is ribbed.

Wide-faced gears of large pitch are used in the driving mechanism. A four-step cone with the back gears gives eight speeds to the ram. All the shafts of the machine as well as the hangers of the countershaft are provided with approved ring oiling journals. The maximum stroke of the machine is 26½ inches, vertical adjustment of the table 15 inches cross motion of the table 32 inches. The net weight of the machine is 4,600 pounds.

SPRING THREADING TOOL.

Mr. J. W. Eagan, 170 Holland Street, Syracuse, N. Y., makes the spring threading tool shown in two different arrangements in Figs. 1 and 2. As shown in the first cut a V-thread tool made from a square bar of steel is used. The "goose-neck" form given to the holder allows the cutting edge to spring away from the work every time there is a tendency for it to catch, so that even in cutting such materials as cold rolled steel it is easy to avoid a ragged thread. The thumb-screw shown as bearing on the rear end of the blade allows the

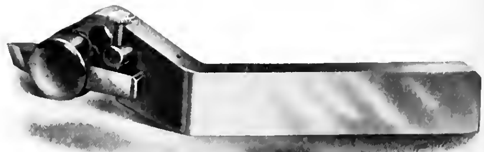


Fig. 1

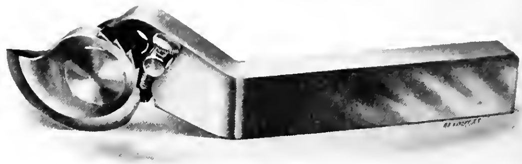


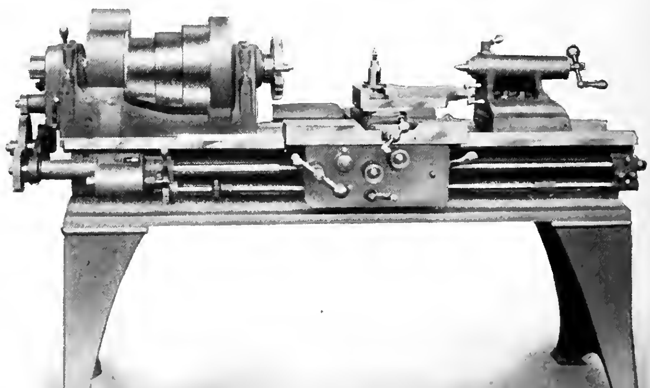
Fig. 2.

tool to reset in its former position after grinding and furnishes as well an abutment which prevents it from tipping up. When used with a circular formed cutter, as shown in Fig. 2, this thumb-screw engages notches formed in the rear half of the cutter to prevent it from being shifted by the pressure of the cut. As arranged in Fig. 1 self-hardening steel bar may be used, no forging being necessary.

SIXTEEN-INCH SPRINGFIELD STANDARD LATHE.

This lathe has been put on the market by the Springfield Machine Tool Co., Springfield, Ohio, with the intention of meeting the demand for an engine lathe which should be fitted for all around service in the machine shop and which should, without being highly specialized, be able to use tools of high speed steel to the full limit of their capacity.

The head stock is driven by a three-step cone of 11-, 9¼-, and 7½-inch diameters for 3¼-inch belt. The spindle may be driven direct or through either of two ratios of back gears of 3 to 1 and 9½ to 1 reduction respectively. This arrangement



Springfield Standard Lathe.

delivers sufficient power to the spindle to allow it to take care of the heaviest work within its range without imparing its utility for rapidly producing work of finer character. The spindle, which has a 1 5-16-inch hole through its entire length, runs in ring oiling bearings which may be replaced with new

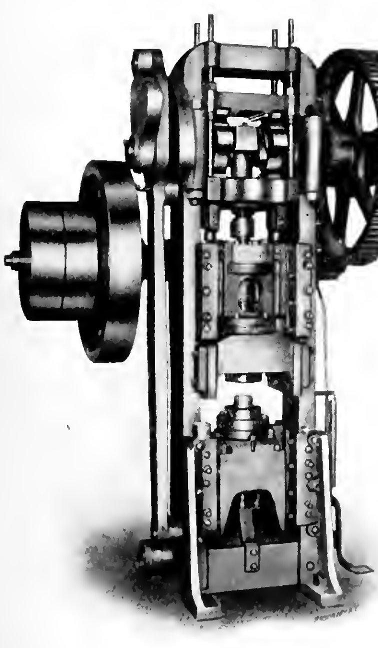
ones in case of accidental damage and still maintain its original hardness.

In the machine shown in the cut six changes of feed are provided for each combination of change gears used at the end of the head stock. With suitable change gears in place for any thread it may be desirable to cut, this change of feeds will have a sufficient range to cover everything required from a heavy roughing chip to a fine finishing feed. The carriage, apron, compound rest, tail stock, and follower rests are all of standard design, very heavy and rigid and supported by a deep and well proportioned bed. The lathe will be furnished with English or metric lead screws if desired, or with the rapid change gear device, oil pan, tank, pump and piping, or such other attachments as may be required to suit the purchaser's needs.

THE BLISS TRIPLE ACTION DRAWING PRESS.

The half-tone below shows the front view of a triple-action drawing press which its makers, the E. W. Bliss Co., 5 Adams Street, Brooklyn, believe to involve a new and valuable principle. The machine is designed for performing drawing operations in sheet metal, the point of novelty in its operation lying in the fact that the work is drawn twice at every stroke of the machine. Briefly this action may be described as follows: The blank is placed on the lower die, which is raised against the stationary blank holder by the rod and cams on the outside of the frame. This holds the blank in place. Next, the outer slide is forced down by the cams to perform the preliminary drawing, after which the eccentric brings down the inner ram to draw the shell a second time. As the punches and dies return to the first position the work is ejected.

This type of press is especially useful and economical for drawing deep seamless shells doing away entirely with annealing first operation shells, inasmuch as the second operation immediately follows the first, while the metal is still warm. Future experience only can determine the full value of the machine, but it is interesting to know that a tin shell 3 inches in diameter by 3 inches deep has been successfully made at one

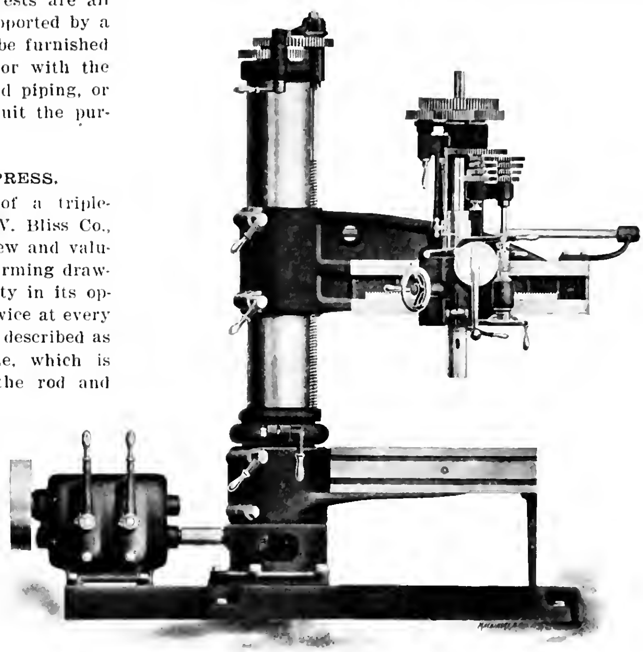


Bliss Triple-action Drawing Press.

stroke of the press. In the size illustrated the capacity is sufficient for a blank 11 inches in diameter and a drawing punch up to 6 inches in diameter. It will draw up to 3 inches in depth and lift out the work for that distance. The press is of very compact construction and occupies no more room than any double-action press of the corresponding size. It may be set in an inclined position to allow the finished shell to fall off by gravity.

AMERICAN TOOL WORKS PLAIN RADIAL DRILL.

The American Tool Works Co., Cincinnati, Ohio, have entirely re-designed their line of radial drills to meet the in-



American Tool Works Radial Drill.

creasingly severe conditions these tools now have to meet. The accompanying cut shows the latest form of plain radial drills with geared drive in the size with three-foot arm. The column is of the double tubular type. The outer sleeve revolves around the central column and is clamped to it in any position by a patented V-clamping ring. The arm has a tubular section to resist the torsional stresses and a parabolic outline to give the proper distribution of metal to afford stiffness against bending pressure. It is clamped to the column by two binder levers and is raised and lowered by power through a convenient lever. The speed box is of the geared friction type with four changes of speed. This in combination with back gears in the head gives eight changes in all. The speed box can be easily interchanged with a cone by simply breaking a coupling connection on the lower driving shaft of the machine since the base is tapped and drilled for either mechanism.

The head is moved on the arm through an angular rack and spiral gear, a clamping lever being provided for binding it in the desired location. The back gears are located in the head thus avoiding the severe torsional stress of the long driving shafts which results from having the back gears at the top of the column or in the speed box. The reversing mechanism for tapping is also located on the head, thus giving frictions the benefit of the back gear ratio and making unusually heavy tapping operations possible, besides permitting the backing of the clamps at an accelerated speed The lever for starting, stopping and reversing the spindle is controlled at the head from the front of the machine. The feeding mechanism is driven by a set of gears giving four changes covering a carefully chosen range in geometrical progression from 0.0069 inch to 0.0203 inch. These gears while giving all the advantages of the quickness of change and power of action which results from a geared feed, drive the wormwheel through the friction arrangement which permits a drill to be crowded to its limit without danger of breaking.

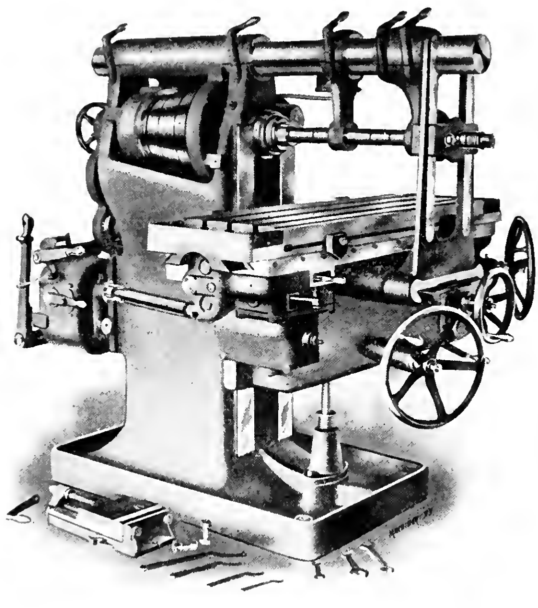
The regular equipment of the machine includes a plain box

table with a top surface of 16 inches x 32 inches, and a side surface of 6 inches x 32 inches, the latter giving the equivalent of an angle plate. Both top and side surface are accurately planed and supplied with large T-slots. Countershaft and cone pulley drive are regularly furnished. At extra cost the speed box above described and illustrated will be furnished, together with swiveling table, round table or improved electric motor application. For the 3-foot size the machine will drill to the center of a circle 6 feet 2 inches in diameter, will take 4 foot 3 inches between the end of the spindle and the base will feed the drill 10 inches in depth and has a traverse of head on the arm of 2 foot $4\frac{3}{4}$ inches.

NO. 4 BECKER-BRAINARD PLAIN MILLING MACHINE.

The spindle of this machine is of hammered crucible steel with a $\frac{3}{4}$-inch hole through its entire length and runs in self centering boxes arranged to compensate for wear. It has a slot across the front to engage a corresponding clutch on the arbor and is threaded to take a chuck, this thread being protected by a collar when the chuck is not in use. The driving cone has three steps, of which the largest is 14 inches in diameter and the smallest $11\frac{1}{2}$ inches. A $3\frac{1}{2}$ inch driving belt is used. The spindle is double back-geared $3\frac{1}{4}$ to 1 and 10 to 1, giving 9 speeds with a single speed countershaft or 18 speeds with a double speed countershaft.

As may be seen from the cut, a positive quick change feed is provided, motion from it being transmitted from the spindle to the feed box through a train of spur gears. Without



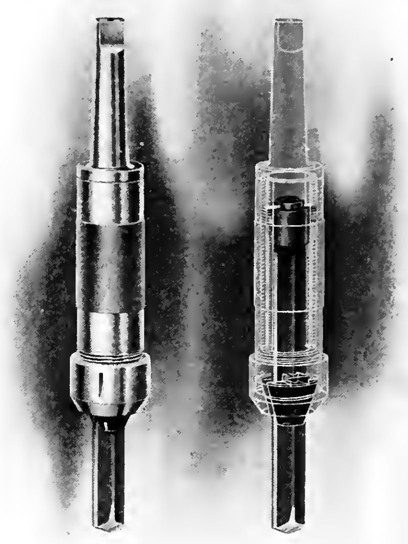
No. 4 Plain Milling Machine.

stopping the machine, twenty changes of feed sufficient to cover the working range of the machine may be instantly attainable. The power feed is applied to the longitudinal movement of the table, cross movement of the saddle, and the vertical movement of the knee, all the handwheels for operating these movements by hand being permanently attached to the machine and provided with a clutch mechanism which allows them to be disengaged when not in use.

The overhanging arm is of steel designed for horizontal adjustment and has an arbor support which may be removed so that any of the attachments may be placed in position without necessitating the reversal of the arm. The net weight of the machine is about 7,100 pounds. The table is 60 inches by $16\frac{1}{2}$ inches over all with a length of feed of 46 inches. The cross feed is 14 inches and the vertical movement of the knee 20 inches. The end of the spindle is bored to No. 12 Brown & Sharpe taper. The machine is built by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

THE RICH DRILL AND CHUCK.

The drill, and the chuck for holding it, which are shown in the accompanying cut have resulted from the attempts of its makers to design the best possible tool for drilling holes in hard materials with drills of modern high-speed steel. This flat drill is made from a bar of the best material obtainable for the purpose, is rolled to the required shape, tempered carefully throughout its entire length and ground afterwards to accurate size. The chuck in which it is used is long enough to support a full length drill close to the cutting edge when working in short holes. As the tool is worn down by the sharpening of the cutting edge, the adjustable abutment shown in the sectional view of the chuck is screwed out to keep the drill projecting the proper amount. Both the gripping of the jaws on the drill and the adjustment of the abutment are controlled by knurled collars on the outside of the chuck.



The Rich Drill and Chuck.

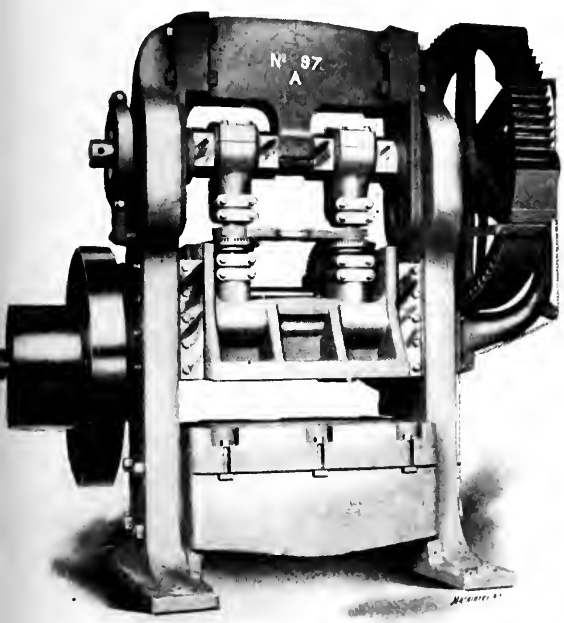
The makers, the Geo. R. Rich Mfg. Co., Buchanan, Mich., report favorable results from a large number of tests of this tool in competition with ordinary twist drills, twist drills of high-speed steel, and forged flat drills of various lengths and diameters. Some of these tests were made under government supervision at the Brooklyn Navy Yard. Ten holes were drilled in armorplate turrets on the Battleship Connecticut with a $1\frac{1}{4}$-inch Rich flat drill when eight twist drills had been used without finishing one hole.

The advantages of these drills may be summed up as follows: Being made of high-speed steel they will take heavier feeds and run at higher speeds than will ordinary twist drills; their strength and endurance suits them for materials too hard and tough for ordinary tools; they will retain their sharp cutting edges much longer than twist drills and are more easily sharpened when dull, being tempered throughout their length they can be used to within two inches of the end, permitting the maximum economy in the use of the expensive material of which they are made; if the drill is broken either of the pieces, if longer than two inches, may readily be ground to a cutting point and used again; they are much stronger torsionally than twist drills; they are so held that only so much of the drill will project from the chuck as is necessary to penetrate the piece being drilled.

DOUBLE PITMAN BLANKING PRESS.

The press shown in the accompanying half-tone was designed for use in the large electrical manufacturing concerns of the country, for special blanking, and compound perforating and cutting dies of extra large size. Its usefulness of course is not limited to this class of work as it is adapted for all heavy blanking and forming operations within its range.

The frame is of the four piece type, the housing being unusually heavy at the shaft opening, which practically eliminates the liability of fracture through accident at this point. Both the bed and the arch take the thrust of the die against solid abutments on these side housings, making the whole structure nearly as efficient as a solid casting would be. In addition to these abutments for taking the thrust, each joint is held together by four heavy bolts on each side machined to fit reamed holes. The crankshaft and connection screws are made of high carbon hammered steel. The connection screws are fitted with bevel gears and pinions for quick and positive adjustment. To give all the strength possible to this adjustable connection, the four threaded caps which are tightened down on the screws to lock them, are machined and scraped to a shoulder bearing, in this way throwing the strain in heavy work directly onto the solid metal of the connection. The lower connections are machined to fit the solid metal in the slide, thus making use of the shaft or stud for lifting the slide only. The press is double back geared with a ratio of 30 to 1. The gearing is machine cut from the solid, the clutch gear running loosely on the shaft outside the main bearing. The clutch faces on the gear and the steel clutch collar are fitted with three hardened tool steel surfaces each.



A Large Toledo Blanking Press.

This feature is not very distinctly shown in the cut. The clutch is of the three engagement pattern, released by means of a weight which throws the releasing roll in contact with a cam on the steel collar. The gravity release gives a more positive action than does the use of a spring for actuating the releasing clutch. The outer arm which may be seen running out beyond the large gear is used for supporting the gravity releasing adjustment only, and not as an outboard bearing to the main shaft.

Some of the measurements of this machine are as follows: Width between uprights, 61 inches; slide area, 32 inches front to back, and 41 inches right to left. Bed area, 48 inches front to back, 60 inches right to left; bed opening, 32 inches front to back, 48 inches right to left. Ratio of gearing, 30 to 1. The press has a capacity of about 60 tons pressure and weight 72,000 pounds. The builders, the Toledo Machine & Tool Co., of Toledo, Ohio, furnish these machines in fifteen different sizes. The construction is such that various widths between uprights may be obtained, ranging from 60 inches to 96 inches, or greater.

AN INK FILLER FOR RULING PENS.

The accompany illustration shows a handy filler for ruling pens that has been placed on the market by Armand W. Benoit, Tufts College, Mass. This filler is designed to take the place of the ordinary quill filler supplied with Higgin's ink now so universally used by draftsmen. It consists of a stopper similar to that usually provided but it is fitted with a small pipette consisting of a rubber bulb and a glass tube. The tube being of small diameter carries little or no ink on the outside when the filler is removed from the bottle, thus enabling the operator to control the amount of ink supplied to the pen. The tube is small enough to enter between the nibs of the pen and does not trouble by depositing ink on the outside, which is one of the annoyances of the quill filler, making it usually necessary to wipe off the outside of the nibs after filling. Although the tube is of glass the danger of breaking through accidentally dropping is slight as the bulb is much heavier than the tube and will always strike the floor first. In using this filler it is not necessary to shake or invert the bottle after the ink has become half used up. It may also be used to withdraw ink from the pen if desired, instead of wiping it out.

An Ink Filler for Ruling Pens.

SCREW SLOTTING DEVICE.

A new screw slotting device designed primarily for use with the "Cataract" bench lathe is shown in the half-tone. The base, as may be seen, is intended to be clamped to the bed of the lathe; a V-block supported by a stem may be clamped in the base at a height determined by the knurled nut which is threaded upon it. Within this V-block may be placed a square chuck holder fitted to receive the regular spindle chucks furnished with the machine. This chuck is tightened by the small hand wheel shown and is limited in its movement by the lock nuts which are threaded to its rear end. The way in which it is used will be readily understood. The The work is gripped in the chuck and fed to the saw or cutter mounted in the lathe to a depth determined by the ad-

Screw Slotting Device.

CONTENTS FOR MARCH.

justable nuts. The work may be removed and a new piece substituted which will be operated upon by the cutter in the same way, since the relations of the work and cutter are not disturbed. The device may be quickly applied to the lathe for such jobs as screw cutting, repairing, model making, tool making, and even for some manufacturing work it is economical and practicable. The tool is manufactured by Hardinge Bros., Chicago, Ill., and will fit in any standard bench lathe.

* * *

FRESH FROM THE PRESS.

MANNHEIM & MULTIPLEX SLIDE RULES. By L. W. Rosenthal. Published by Eugene Dietzgen, 119 to 121 West 23d Street, New York City.

This pamphlet is divided into three sections, the first of which is a general treatise on slide rules. The second deals with multiplex slide rules made by this company, giving full directions for their use. Part third is devoted to tables and conversion ratios.

MACHINE SHOP ARITHMETIC. By Colvin and Cheney. Published by the Derry Collard Co., New York. New edition. 144 pages. Illustrated. Price, 50 cents.

This little book has passed through many editions and appears to be more popular than ever with machinists and mechanical men. It explains calculations most used by shop men, but it does not give these in a rule-of-thumb manner. It outlines in each case the principle of the calculation so that a person will understand what he is doing and why he is doing it. There is therefore no chance to go wrong if a person takes pains to read the explanations given. There have been some additions in this new edition. They include metric threads, force, shrink and running fits, etc. The book is now bound in flexible covers.

HYDRAULIC POWER ENGINEERING. By G. Croydon Marks. Published in this country by D. Van Nostrand Co., 23 Murray Street, New York City. 388 pages. Illustrated. Second edition, revised and enlarged. Price, $3.50.

This treatise deals with hydraulic motors and turbines and with various types of other hydraulic machinery, such as cranes, accumulators, hydraulic presses, etc. The present edition has been enlarged by the addition of material especially upon hydraulic presses and lifting machinery, there being about 40 new illustrations. Pumps are dealt with only to a limited extent. Numerous types of controlling valves are shown for elevators, cranes, presses, etc. The treatment of turbines is less mathematical than in most works, but appears to be satisfactory and includes calculations involved in turbine design. The illustrations are well executed and the book is useful as a general work of reference on different types of hydraulic machinery.

KLINE'S PIECE WORK RATE SETTING TABLE is the title of a book compiled by Archibald L. Kline, Chicago, Ill. It is bound in morocco and printed on ledger paper, and is pocket size. Published by Glenum and Kern, 265 La Salle Street, Chicago. Price, $5.00.

The piece work system is now almost universally adopted in all large industries in the United States. This system has greatly increased the labors of those whose duty it is to make the estimates thereof. Mr. Kline's book consists of tables prepared for his own use in a large manufacturing plant, and they have been found so useful that they are now presented in book form. They are arranged in four main divisions seven, eight, nine and ten hours, representing the different lengths of day's work. Each of these tables, in turn, is again arranged into sub-divisions of seconds, minutes and hours. The tables apply to wages ranging from 75 cents to $5.00 per day, showing piece rates per 100 pieces, and time required to do one piece, the number of pieces per hour and the number of pieces per day.

The reason for having four divisions is explained as follows: A shop working ten hours cannot expect its employes to work every second in the day, as there is time lost in taking care of the machine, sharpening tools and other justifiable loss. The actual working hours are best determined by the foreman or the man in charge of the work. If the time lost is one hour, then the piece rate should be set by using the nine-hour table.

In the use of the tables it is necessary to know the time required for completing each piece, or the number of pieces completed in a day. This can be best ascertained by the use of a stop watch. For example, suppose the actual time is nine hours, and it is desired that the employe shall earn $2.25 per day. It takes 21 seconds to complete a piece. Look up this time in the suitable table and find the corresponding number of pieces that can be done in one hour at that rate of speed and the number that can be completed in a day. Under the wage column of $2.25 is found the rate to be paid per 100 pieces.

NEW TRADE LITERATURE.

THE WATSON-STILLMAN CO., 46 Dey Street, New York City. Catalogue No. 68, dealing with Hydraulic Jacks. This is another edition of No. 61, and contains some new sizes and a few new cuts. Several new pages are inserted in the back, listing their various catalogues.

THE AMERICAN BLOWER CO., Detroit, Mich. Catalogue No. 186, devoted to A. B. C. Heaters. A general description, description of construction and capacity are taken up, and various types of heaters, in combination with fans, are illustrated.

HENRY & WRIGHT MFG. CO., 111-137 Sheldon St., Hartford, Conn. Catalogue of Ball Bearing Drill Presses and Filing Machines. Illustrations of a number of different types are given and several pages are devoted to the Idler system. The Hartford Bench Filing machine is also described and illustrated.

CRANE CO., Chicago, Ill. Advance Circulars Nos. 01, 2, 3, 4S. D. V., 5, 6, 7, 8, 9, 10, 11, 12C. S. T., 14, 15, 17, 18, 19 and 20. These treat of steam and oil separators, various types of valves, pipe dies, heavy flanged pipe joints, reversible stop and waste cocks, brackets, hangers, supports, rolls and anchors, steam traps, drip pockets and pipe bends.

LODGE & SHIPLEY MACHINE & TOOL CO., Cincinnati, O. Catalogue R, containing descriptions of their various lathes, which are designed especially for the use of high-speed steel. This catalogue takes up details and specifications of the engine lathe, patent head lathe and accessories. It presents an attractive appearance, being an artistic piece of printer's work, and illustrated with excellent engravings.

THE B. F. STURTEVANT CO., Boston, Mass., will hereafter issue most of its publications periodically under the title, "Sturtevant Engineering Series." Each individual bulletin will treat of some particular product or its application. The series will also include reprints of pertinent articles or technical papers. All publications will be issued in uniform style and size suitable for binding consecutively or in allied groups. Bulletin No. 125, the first of this series, has just been published. It describes in detail the line of automatic vertical engines manufactured by the B. F. Sturtevant Co.

MANUFACTURERS' NOTES.

THE DIAMOND CHAIN & MFG. CO., Indianapolis, Ind., have taken up the manufacture of automobile parts, and are now prepared to furnish same to trade.

H. W. CALDWELL & SON CO., Chicago, Ill., have secured the services of Howard W. McLean, who was for a number of years superintendent of the Link Belt Mchy. Co., as consulting engineer.

THE F. W. SPACKE MACHINE CO., Indianapolis, Ind., manufacturers of air compressors, have outgrown their old plant and will break ground in thirty days for a large addition to their factory.

THE FREVERT MACHINERY CO., New York City, have opened their new salesrooms at 18 Dey Street. They handle a full line of new and second-hand machinery, traveling cranes, hoists, etc.

THE well-known company of Pedrick & Ayer, formerly of Philadelphia, now located at Plainfield, N. J., has been purchased and will hereafter be operated by the Railway Appliances Co., Chicago.

McDOWELL, STOCKER & CO., Chicago, Ill., announce the opening of a branch office in Milwaukee, Wis., Room 51, Loan and Trust Building, Second Street and Grand Avenue. The office will be in charge of J. R. McDonald.

MR. ARTHUR FALKENAU announces that he has retired from his manufacturing and engineering business and has opened an office as consulting engineer and expert, 919-920 Witherspoon Building, Philadelphia.

THE TOLEDO MACHINE & TOOL CO., Toledo, O., designers and builders of special machinery as well as a long line of bar and sheet metal working tools, report a most gratifying increase in their export trade. They are making heavy shipments to France, Germany, Belgium and Holland, and are also doing an unusually heavy business in Canada.

THE EDGMONT MACHINE WORKS, Dayton, O., have recently become incorporated under the laws of Ohio as the Edgmont Machine Co., with a capital of $15,000. The president is George Stahl; secretary, W. P. Coffman; treasurer, J. I. Coffman. The firm will be engaged in manufacturing clutch pulleys.

THE CLEVELAND PLANER WORKS, Cleveland, O., manufacturers of open side planers, have made a large addition to their factory, which more than doubles their floor space. They expect that their increased facilities will enable them to more easily handle their growing business.

THE BATES FORGE CO., Indianapolis, Ind., have just installed a new 4,000-pound Chambersburg steam hammer which will enable them to better care for their rapidly increasing business. They report a specially good business in their truck and sheave wheels, which are forged from bar steel and have half the weight and double the strength of castings.

THE S. OBERMAYER CO., Cincinnati, O., have recently purchased the foundry supply factory of H. S. Vrooman, Chicago. The entire factory of this concern as well as their stock of merchandise has been moved to the Chicago plant of the S. Obermayer Co., from where all orders of this department will be filled.

L. BEST announces that his business will hereafter be carried on by the L. Best Co., a corporation organized under the laws of the State of New York, having the exclusive agency for the sale of the Sterling emery and corundum wheels. They will also manufacture and sell emery grinding and polishing machinery and polishers' supplies. The general management of the business will remain as before.

C. H. BESLEY & CO., 15-21 S. Clinton Street, Chicago, Ill., report shipment of their spiral grooved disk grinders during the past week to Cologne and Berlin, Germany; Milan, Italy; and Athens, Greece.

MACHINERY.

April, 1906.

A HEATED PISTON ENGINE.

CHARLES R. KING.

IN engines of large size running at moderate speeds jacketing the cylinders with steam either at the same or at a higher temperature than that supplied to the cylinders has long been recognized as favorable to economy. The effect of the steam in the jacket is to reduce the rise and fall of the cylinder temperature due alternately to the admission and to the early cut-off and expansion of the steam. If steam of high temperature is used in the jacket the working conditions in the cylinder are of course more favorable than where steam of a temperature corresponding to the boiler pressure is used. An alternative method that has been proposed is to employ boiler steam without superheat for the jacket and also to supply boiler steam to the inside of the piston by means of a hollow piston rod. Such an arrangement would be perfect for the back end of the cylinder but at the front end where the piston rod must necessarily pass 50 per cent of its working life outside of the cylinder thereby causing a loss of temperature in the front end of the cylinder, the conditions are not so favorable; but the loss from this cause can at least be mitigated by means of the hollow piston rod filled with boiler pressure steam.

The suggestion that the piston shall be heated has been made several times in the past years and in particular by Lacroise in 1895 and it was again recommended in 1896 by the technical committee charged with the preparation of the steam engine programme for the Brussels exhibition. The study of the subject was then taken up by W. M. Francois, an engineer of the designs department in the great steel works of the Société Anonyme John Cockerill of Seraing near Liége, Belgium.

The heated piston was first applied in 1901 to a Corliss engine that had been laid aside in one of the shops. This was a single-cylinder non-condensing engine and in 1902 the results obtained from it were so satisfying that the machine was fitted with a condenser. It then worked with such remarkable efficiency that in 1903 a specially-built engine was constructed with Racher valves and in 1904 an engine with piston steam valves, and with cut-off or expansion valves worked by trip gear, was built and gave yet better results. A machine later exhibited at Liége International Exhibition is similar to the last engine mentioned. A general view of the engine as installed at the Exhibition is here given together with the drawings. The piston, it will be seen, consists of two hollow heads bolted by their inner faces to a hollow sleeve having flanged ends and which gives the hollow piston a total length equal to one and a half times the stroke of the piston. The separation of the piston heads by an interval equal to the length of the stroke allows direct contact of the steam within the piston against the cylinder walls. The method of securing the piston heads to the piston rods is specially designed to prevent them from working loose and also to free the rod from all stresses due to re-action in the inside faces of the piston heads. The rear piston is keyed to the rod itself while the latter is screwed in the reinforced end of the piston tie or sleeve.

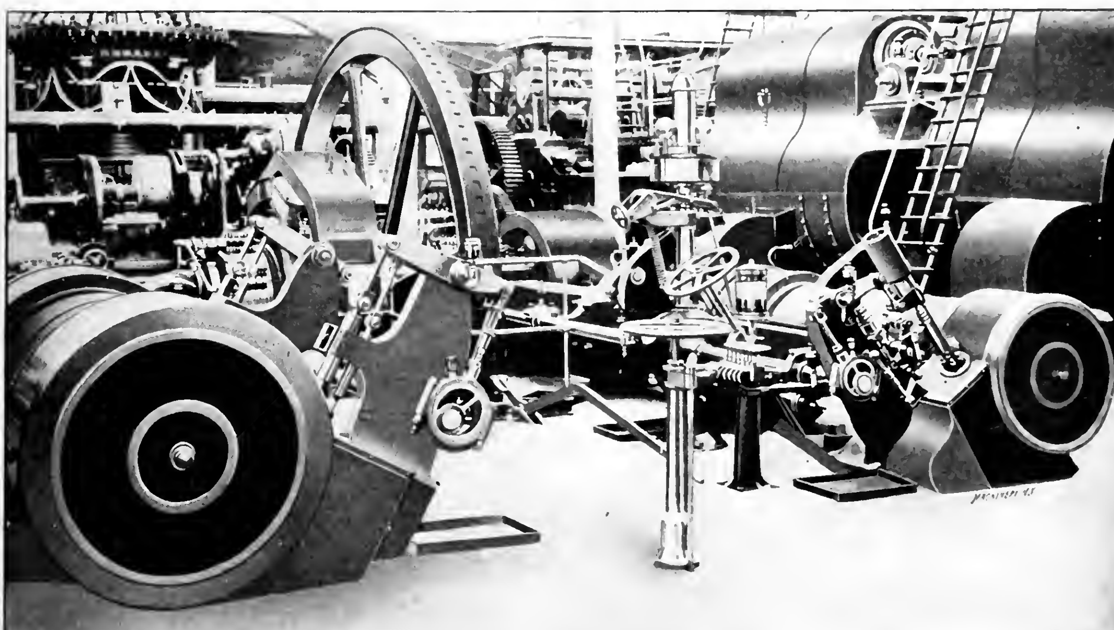


Fig. 1. Compound Engine, Jacketed, and with Heated Pistons. Built by John Cockerill, Belgium.

The cylinder is of unusual construction. It consists of two parts, set in the outer casing or jacket in such way that there is always communication between the jacket space and the neutral space between the two piston heads. Steam thus interchanges between the jacket and the space between the pistons. There are only two flanged joints in the cylinder, as in ordinary cylinders, these joints being situated a little way back from the cylinder ends. Each half of the cylinder proper is cast in one piece with the cylinder end which comprises the jacketed end cover and the valve chest. The two cylinder ends are bolted together by means of the short barrel casing forming the mid length of the steam jacket. The three distinct parts are rigidly secured together and in due alignment by means of the flanges mentioned and by the ribbed seatings located near the inside extremities of the cylinders which per-

mit of temperature movements in the cylinders. The cylinder proper is entirely enveloped in steam and always has over 50 per cent of its length filled with steam of the pressure and temperature of that supplied to the valve chests. The efficiency of this internal heating is increased by the action of the hollow piston which keeps the steam entering at the middle of the jacket in continual movement while it also drives out at each stroke any water which may have condensed in the cylinder jacket. Particular care is taken to prevent any such condensed water from being carried through into the cylinder. By reference to the end cross section at the valve chest it will be seen that deep cavities are formed around the ends of the valve chest where such water would be carried, and at the lowest end it is drained away by an automatic forge cock and at the upper end the valve chest liner projects much above the lowest annular space of the steam chest. The piston valves being hollow, the steam circulates through them and so around the whole circumference of the cylinder.

The objects of the new form of steam distribution here employed are to permit high pressures and speeds and to keep the clearance volumes as low as possible—that is, at about the same as obtained with Corliss valves. The type of duplicate valve employed in this engine is that of Meyer and Farcot. The outer valve is the steam valve actuated direct from the eccentric and its articulated connections; the inner valve is the expansion or cut-off valve released by trip-gear. In the valve liner are two parts, one corresponding with the large opening in the wall of the cylinder, and the other, opposite and lower down, with the exhaust. In the half-tone illustration the exhaust shown is from the high-pressure to the low-pressure cylinder—the engine being of the cross-compound type.

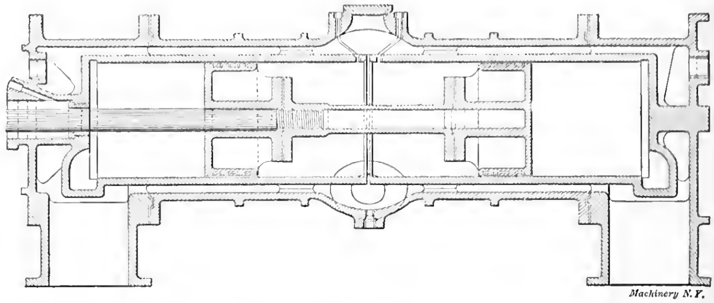


Fig. 2. Section of High-pressure Cylinder showing Method of Admitting Steam between Piston Heads.

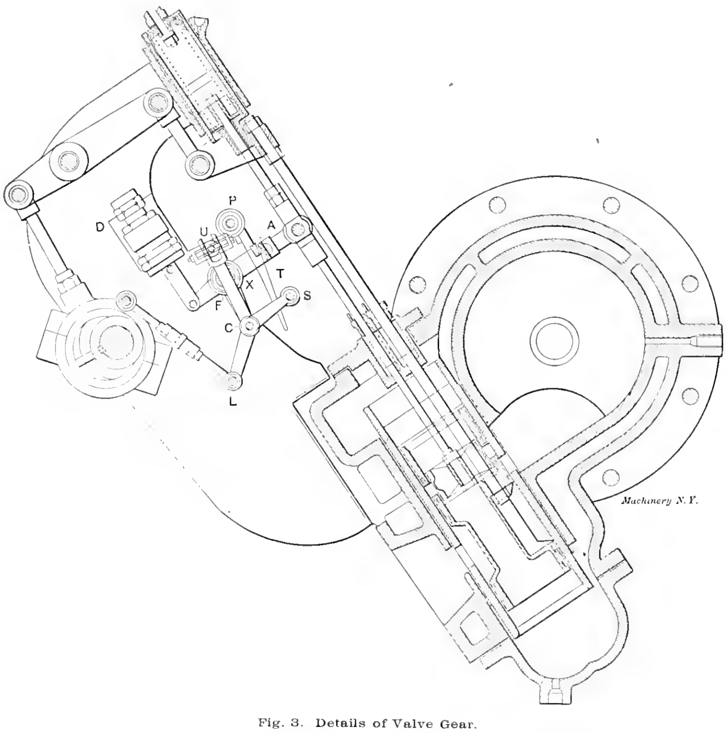


Fig. 3. Details of Valve Gear.

The main or steam admission valve has in its upper half a port milled in its side to correspond with the cylinder port; and its lower half is so contracted, through a part of its length, that there is an annular passage around it for the exhaust from the cylinder. This valve is operated by the right-hand spindle (see cross-section of cylinder). On the inside of this valve works the cut-off piston valve operated through the central spindle. When the main valve is lowered it admits steam; when raised it exhausts the cylinder. The action of the expansion or cut-off valve is as follows: Fixed at the upper extremity of its spindle is a small piston working in a cylindrical box containing a helical spring. This box is fixed to the spindle of the other valve and it is guided in a cylindrical fixed bracket (see Fig. 1).

During the upward travel of the main valve the inner valve must follow it, because the piston guide of this latter is then seated at the bottom of the cylindrical box fixed to the extremity of the main valve spindle. Consequently the cut-off valve in this position keeps the steam port in the main valve covered. At the top of its travel the expansion valve is caught and held up by means of a tappet *A* articulated about the mid length of the expansion valve spindle, which, in rising, becomes engaged in a lip upon a trigger lever *T*, where it remains practically fixed during the downward travel of the steam admission valve. The cut-off valve, however, is permitted to follow and so keep near to the port in the main valve in order that, at the instant of release it may have a minimum of distance to travel in the shortest space of time possible. It may be added here that this result, previous to release, is realized by the arrangement made in connection with the trigger lever *T* pivoted at *P*, which lever can be depressed within the limits permitted by a coiled spring in the dashpot *D*, through the intermediary of the fulcrum-lever *F*. The release of the cut-off valve takes place when the striking lever *S*, turning on the center at *C*, by means of the articulation shown in connection with the eccentric strap, presses upon the trigger lever in disengaging the tappet *A* from the support.

The main valve stem in its descent had compressed the spring contained within the box at its extremity and this spring when the release of the trigger-lever occurs, projects the cut-off valve downward over the steam port in the main valve. High piston speeds are favored by this arrangement for while the steam valve is connected direct with the eccentric motion, the fall of the cut-off valve, depending for its speed upon the elasticity of the spring, remains practically invariable for all speeds.

Very short cut-offs are effected by giving a certain amount of advance to the trip gear in anticipation of the rearward course of the piston. The admission may be varied from 0 to 60 per cent of the stroke but the height of fall for the expansion-valve remains nearly constant and the speed of the engine always above 120 revolutions (the engine illustrated is of 300 H. P.). The governor regulates the speed by changing the point of cut-off, and therefore the degree of expansion, through variations in the position of the arm *S O* in its relation to the arm *C L* and therefore with respect to

the eccentric, this being effected by a crank keyed upon the axis *X*, and acting upon the forked lever *U*. The axis or shaft *X* is, it may be added, turned by the sleeve of the governor.

In the machine illustrated, the second of its type, the governor is only connected to the valve mechanism of the high-pressure cylinder, the regulation of the low pressure valve motion being effected by hand. The distribution at each of the four valve chests can be modified at will even while the machine is running. In the case, however, of engines working under heavy loads liable to considerable and sudden fluctuations the arrangement can be combined so as to regulate the low-pressure cylinder, also from the governor. Despite the seeming complication of the valve mechanism it is in reality a very simple form for trip-gear machines, since there are only fourteen joints for the distribution and exhaust at each cylinder end.

The clearance volumes (piston clearance and steam passages) average, in ratio to the volume swept by the piston in each stroke, 2.88 per cent for the small cylinder and 2.6 for the large cylinder, proportions which are certainly not remarkable; but as regards the surfaces of those volumes—which are of more importance than cubic content—they have been diminished to an extent seldom realized, these being, in ratio to the pistons' surface, only 3.68 per cent (averaged) in the small cylinder, and 2.95 per cent (averaged) in the large cylinder.

The cylinders have diameters of 375 mm. (14.76 inches) and 650 mm. (25.59 inches), with an equal stroke for both of 750 mm. (29.53 inches). The piston rods are 75 mm. (2.95 inches) diameter for both cylinders.

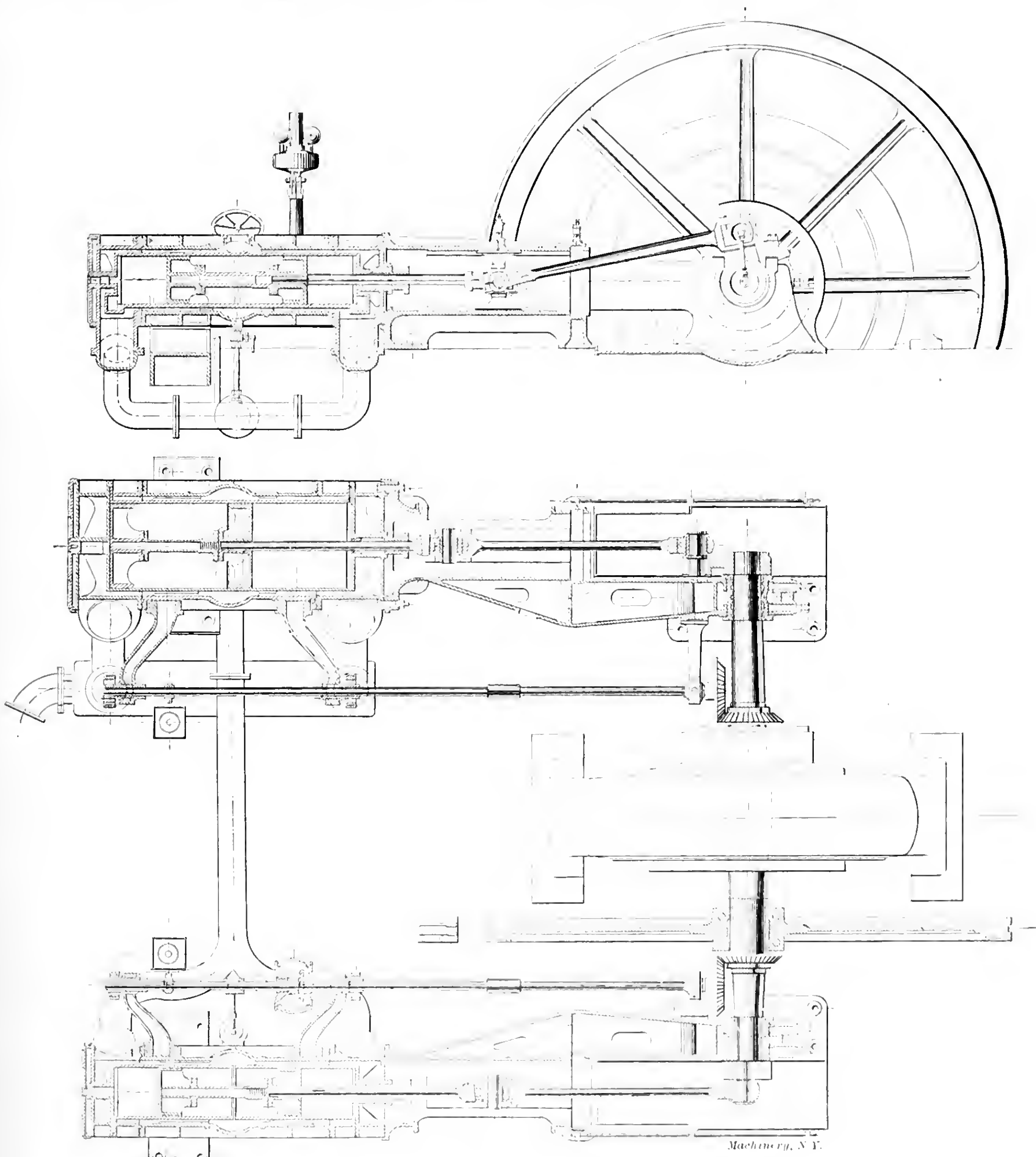


Fig. 4. Sectional Elevation and Plan of Cockerill Engine.

The receiver for the high-pressure exhaust is replaced by the steam jacket itself of the low-pressure cylinder—a practice largely followed in the Cockerill engines at Liége, including the 10,000 H. P. rolling mill engine standing alongside the machine under mention where the three high pressure cylinder jackets serve as the intermediary reservoir between boilers and engine.

A very elaborate series of trials conducted by the eminent professor of the Liége University, Mr. W. H. Hubert, showed that this engine has a high mechanical efficiency. Designed

for a nominal output of 265 H. P., it can develop 400 H. P. and while running light it only absorbed 23.8 H. P. of its own power. In six different tests the steam consumption varied from 5.09 kilogrammes to 6.06 kilogrammes per metrical horse power hour under conditions of which two examples are cited in the subjoined table.

In column 2 the engine worked with an excellent vacuum in the condenser, but without superheat, and yet the result, in calories per horse hour, is remarkable, it being very little inferior to engines working with high superheat.

	No. 1.	No. 2.
Water evaporated ...pounds..	2425.082	2118.639
Consumption per horse power hour ....pounds..	11.953	11.225
Barometric pressure...inches..	29.881	30.098
Gage (metallic) pressure...... ....pounds..	127.126	125.32
Indicated pressure ...pounds..	19.817	20.282
Vacuum (mercury) ...inches..	26.236	27.885
Initial (admission) temperature ....deg. F..	380.6	355.13
Saturated steam temperature corresponding to 10.deg. F..	353.8	354.99
Condensed water temperature, ... deg. F..	109.4	89.6
Pressure in receiver of L...... ....pounds per sq. inch..	4.55	1.848
B. T. U. expended per H. P. H..	14377.254	13360.652
B. T. U. allowing for 16.......	13450.726	12713.472
Thermal efficiency, based on last item	18.86	19.83

* * *

DESIGNING TWO-POINT BALL BEARINGS.

Ball bearing practice has in late years crystallized into the use of the two-point form almost entirely, this having been found one of the most durable and efficient of the various possible arrangements, as well as the easiest and cheapest to construct. For obtaining the dimensions of the cups and cones in a bearing of this type, the following formulas may be used, in which

D = Diameter of the ball.

R = Radius of the tool used to form the race.

X = Smallest diameter of the cone portion of the track.

Z = Largest diameter of the cup portion of the track.

S = Available space for ball between the cup and cone surface, including clearance.

n = Number of balls.

Y = Diameter of pitch circle through the center of balls.

A, B and C represent dimensions shown in the cut in the April data sheet, sent herewith. The clearance between neighboring balls is taken as 0.003 inch.

$$A = R - \frac{D}{2}$$

$$C = A \text{ Sin. } 26^\circ$$

$$B = A \text{ Cos. } 26^\circ$$

$$S = 2(R - B)$$

$$S - D = \text{clearance of ball}$$

$$Y = \frac{D + .003}{\text{Sin. } \frac{180^\circ}{n}}$$

It will be noted from the cut that the pressure angle is 26 degrees, measured from a line perpendicular to the axis of the journal. Where the pressure is largely end thrust it will be well to take this pressure angle as 26 degrees from a line parallel with the axis of the shaft, using dimension B in place of C and *vice versa*.

In the data sheet sent with this issue of the paper will be found tabulated dimensions for ball bearings of this design, for balls from ¼ inch up to ¾ inch, using from 8 to 30 in each bearing. These dimensions of course apply only to bearings made as were those shown in the cut, with the pressure angle of 26 degrees measured from a line perpendicular to the axis of the journal. When made as suggested above for cases where the end thrust is the more important factor, the dimensions for B and C will have to be transposed. This gives new values for S, $S - D$, X and Z.

THE TEACHING OF MECHANICAL DRAWING.

E. H. FISH.

The teaching of mechanical drawing has always been, so far as the writer knows, a very unsatisfactory matter. The graduates of our high schools and colleges and even of our correspondence schools and technical schools have always fallen short of the expectations of their employers and, if the truth were known, probably have disappointed their instructors. To the shop-educated draftsman this is an anomaly, for to him the mere making of an understandable drawing is the simplest possible thing. Drawing has been called a universal language. If we can look at it as a language to express thoughts rather than as an art, perhaps we can get a better solution of the problem of teaching it. A very distinct dissimilarity between class room work as usually carried on and work as done in drafting offices is to be noticed in at least two respects. First: Class instruction (and correspondence instruction) makes extensive use of the copying of drawings. In copying I include not only the direct copying on the same scale, but also changing the scale. Second: Drawing from models, which is analagous to building a machine and making the drawings afterward.

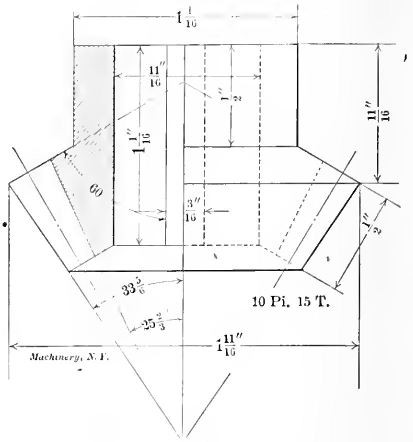


Fig. 1.

Copying, even in its broader sense, is rarely done in drafting rooms. Occasionally a machine is designed which is precisely the same as some other machine of which drawings are already on hand, but this is very rare, for in a line of sizes of machines it seldom happens that they are in direct proportion. The second, drawing from models, is rarely used in drafting rooms. Now if a draftsman does not earn his living by copying drawings or drawing from models, how does he live? My answer is: He draws on paper what his imagination sees. That is he conceives a machine or a certain part of it to be of a certain size and shape. It is not easy for him to convey this impression to the workman by ordinary written language. It may be possible for him to do so, but if he does describe it verbally, he takes long chances of being misunderstood. If he is an expert he may make a perspective drawing of what he wishes made and to another expert it will convey some meaning as to proportion, but not an exact idea of sizes. If he is an ordinary man he can make an ordinary (orthographic) drawing which will be readily understood by an ordinary workman. This is the object, then, that we must have in view in teaching drawing, that we must teach the student to first get a clear mental picture of what he is to draw, and then to draw it. A designer evolves his idea almost in its entirety before he draws a line to guide him as to how the object will look, usually making his design a composite of everything similar that he has seen and thought good. He transmits his idea to his assistants by means of sketches and verbal descriptions, both being as crude as he dares to make them. The draftsman uses these sketches, not to copy from, but as reminders and guides, making his drawings in turn from the mental picture which the designer has impressed on him. The detailer's work is to a certain extent copying from the general drawing, but even he must get a clear mental pic-

ture of what he is drawing before he can make an intelligent representation of it and dimension it.

In approaching this idea in the school drafting room, we have, of course, had to work gradually, trying and testing one feature after another, but the writer has carried the freshman and sophomore instruction under the direction of Prof. Smith far enough at this school (the Worcester Polytechnic) so that we feel sure of its good effect on the students.

We still carry on, in the Freshman year, work in geometrical drawing, given with the idea that from it the student will learn the careful use of instruments and particularly to ink in irregular curves, and also that he will become familiar with curves which he must use later in his mathematics, though this last is apart from our subject. Our work in free hand drawing still bears a faint resemblance to the usual beginner's course in that subject in that we give a few weeks' practice in drawing from models offhand, a little work in pen and ink, drawing and shading, and also a little wash drawing. Beyond this the resemblance fails. We give quite a full but simple course in a form of projection known as axonometric which is a good imitation of perspective and with a little care can be turned into perspective. The use of this enables us to give the students ordinary shop blue prints and have them make perspective drawings of the objects which the blue prints represent and without their having a chance to see the models themselves. We get very fair results, as are shown by the illustrations. Fig. 1 shows the drawing given the student to work from and Fig. 2 the drawing which resulted. If we get any results at all, we can be certain that the student has read the drawing, which is what we wish him to learn to do. While this involves just the reverse reasoning from that which we employed, at the same time it aids the student greatly by training his imagination as well as accomplishing all that can be hoped from copying drawings.

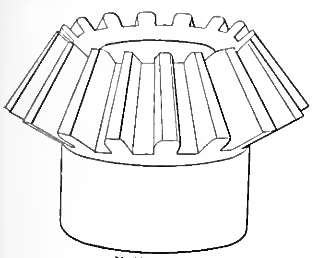


Fig. 2.

Going on further with free hand drawing, we give the students verbal or written descriptions of simple pieces, and also perspective drawings beginning with prisms and running through more difficult pieces, such as bolts, etc., and they make working drawings from this material. These are drawn and inked free hand and are dimensioned. As one of the students put it, it is mechanical drawing under difficulties. In this work, since the student has neither the model nor another drawing to copy, we are sure that he forms an impression of the object before he draws it.

We still give quite a little work both free hand and with instruments in drawing from models, principally for the practice in dimensioning. In this work the instructor takes up with the students a number of typical forms and discusses with them the different steps in the making of the patterns and doing the machine work, showing them how the pieces can be dimensioned so as to enable the workman to make them without having to figure out dimensions for themselves, and trying to impress upon them the necessity of clearly understanding how a piece is to be made before they can dimension it intelligently. We are especially careful that they shall know how every piece that they draw is to be manipulated in all stages of progress, whether in the foundry, pattern shop, forge shop or machine shop, so that later they will be careful to design details with some regard to convenience of manufacture. It has been a constant struggle previously with green "tech." graduates to get them to design castings which can be readily molded, but we feel now that by beginning early we will be able to train men who will, as a matter of habit, look out for these things. When the student is taking this course in drawing, he either has had or is having work in forge shop, foundry, pattern shop and machine shop so that his knowledge is growing uniformly along consistent lines.

After this we give them an assembly drawing of some simple machine like an arbor press, made to scale on a large cross section black board and have them make detail drawings of the separate pieces fully dimensioned and also have them make an assembly drawing of another machine from free hand sketches of the separate pieces. This is followed up by the design of a number of simple parts of machines which do not depend so much for their design on computation as on common sense and observation. We find it advantageous as well as interesting for them to begin to do such simple work as this early in their course, particularly as we wish to impress some conservatism on them and not let them have the idea so prevalent among technical graduates that a design to be creditable must be entirely original and different from anything the world has ever seen.

We also have each year a design of some rather complex machine of which we turn the assembly drawings over to the sophomores to have them make detail drawings. This year this work has been on a 16-inch drill for using high speed drills. The Freshmen are using the drawings which the Sophomores made to make the patterns from, and the Juniors are doing the machine work. So the Sophomores are getting abundant chance to see how their drawings are standing the test of actual use.

We feel that this course is much more nearly in line with actual working conditions than is the usual course in drawing, and we have a decided expectation that when the men who have been through this course graduate, they will find their first work in drafting rooms easier than those who have not had this training.

* * *

CUTTER GRINDER FOR ROTARY PLANERS.

Among the interesting shop devices in use at the Schenectady works of the General Electric Co. are a number of portable machines for grinding milling cutters of the rotary planer type. One of these machines is shown in use on a Newton rotary planer in two views, Figs. 1 and 2, and Figs. 3 and 4 illustrate the principle of its operation. The object sought was to grind the cutters in position in the heads so as to make each do its share of the work, and to avoid the irregular cutting action consequent with any system of grinding the cutters individually and setting them by a gage. But to grind the cutters in position with the head rotating in front of the grinding wheel it is necessary that the wheel be given an in-

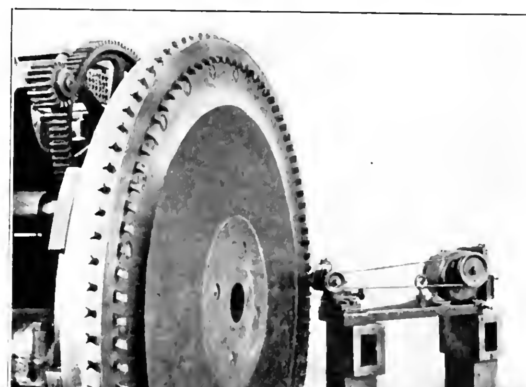


Fig. 1. Grinding the Teeth of a Rotary Planer Head

and-out motion in order to grind the necessary clearance on each cutter. This motion is accomplished by mounting the grinding wheel spindle in an eccentric bushing *G*, Fig. 1, and providing suitable means for its oscillation. As the cutter *K* passes the grinding wheel *A* it engages the actuating lever or finger *C* which rocks the arm *D* on its pivot, and through its

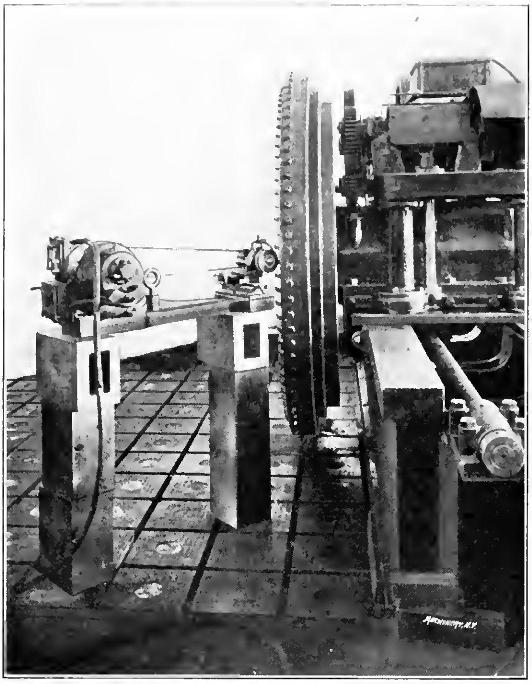


Fig. 2. Portable Grinder Mounted in Position for Operation.

intermediate connection turns the eccentric bushing and thus throws the wheel in closer to the cutter as it passes by. A coiled spring *E* retracts the finger and connected parts to the first position the moment the cutter being ground has passed beyond the grinding wheel. The finger *C* is not rigidly connected to *D* but is pivoted to it so that it has a limited independent motion, being held in the down position by a short

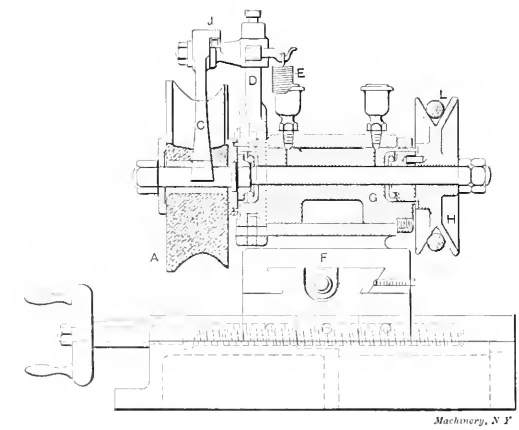


Fig. 3. Section through Spindle of Automatic Grinder.

spiral spring. The purpose of this feature is to prolong the contact of the finger with cutter in order to grind the clearance on the extreme lower corner of the tooth. The grinding wheel has a contour formed to the shape desired for the leading edge of the cutter teeth. The remaining grinding on the flat or finishing cutters is done by a flat wheel placed parallel with the face of the cutter head. It is driven by a motor connected by a round belt, as is plainly evident in views, Figs. 1 and 2 and is mounted on a compound rest so as to give it the required lateral and longitudinal adjustments for grinding. The frame carrying the motor and grinder is shown mounted on cast iron blocks, these being adjuncts of the floorplate system and in common use for blocking up heavy castings, etc.

Mr. John Riddell, who is a joint patentee of the device with Mr. Casper C. M. Mortensen, informs us that the grinder has made a great increase in efficiency of the rotary planers, and that six of them are now in use in the various departments of the works. The planer shown has a cutter head 84 inches in diameter, and after grinding it for the first time with the improved rig, the feed was increased from 2¼ to 5½ inches per minute; the character of the work was also improved, being made smooth and free from the characteristic ridged appearance which almost invariably accompanies the work of these machines. It will be noticed upon close inspection of the half-tone, Fig. 1, that six teeth are placed at equal distances around the cutter head which have extended cutting faces, being designed for smoothing the milled surface. These are ground with the other teeth in identically the same manner but of course the grinding with the formed wheel does not extend throughout the width of the smoothing teeth, the grinding being done with a flat wheel as explained in the preceding paragraph. Clearance is also provided in the same way.

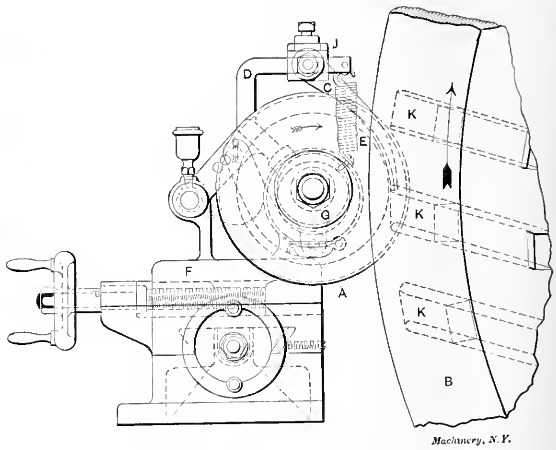


Fig. 4. Side View, showing Action of Tooth on the Finger.

Incidentally Figs. 1 and 2 show the form of floorplate adopted in the new turbine shop, building 86 of the General Electric Co. The floor-plates in this shop is 50 feet wide and 200 feet long. It is built of sections 10 feet square, all bolted solidly together with tongue and groove so that the sections make practically one huge plate. The holes shown in the center of the squares are for filling underneath the floorplate sections with grout. The plates are carefully laid on a concrete bed and leveled up, and then the space beneath is filled by pouring the grout through the holes shown until it is about level with the surface.

* * *

CORRECTION TO DECEMBER DATA SHEET.

In the longitudinal section of the boiler shown on this sheet the dimensions *M M* should represent the width of the air spaces instead of as drawn. Also the dimension *B* should be the distance between the outside of the two boiler heads and the dimension *R* the distance from the outside of the rear head to the brick wall. It may also be mentioned that the dimensions *D*, *H*, *I*, *K*, *L*, *M* and *N* all terminate on rivet lines. They are thus represented on the drawing, but the details are so small that this fact may not be entirely clear.

* * *

The *Scientific American* translates a receipt for casein cement from *Nouvelles Scientifiques* which is said to be valuable for mending broken porcelain, and, of course, any crockery ware. Mix 10 parts of freshly prepared casein (milk curds) with 30 parts soluble silicate of soda (water glass) and 20 parts soluble silicate of potash.

DESIGN OF A RIVETED JOINT.

FRANKLIN H. SMITH

In designing a riveted joint it is first necessary to know the pressure per square inch and the diameter of the cylinder, or the thickness of the metal.

The letters in the formulas used for the design of riveted joints have the following uses; these formulas apply to joints having only one pitch:

t = thickness of the plate.
P = pressure to be resisted by 12 inches of the joint.
D = diameter of the cylinder, in inches.
a = pressure per square inch.
S = ultimate shearing strength of rivet or plate.
p = pitch of rivets.
f = factor of safety = ratio in which the bursting pressure exceeds the working pressure, and is computed by dividing the lowest resistance of the several parts by the resistance of the solid plate.
T = tensile strength of the plate.
d = diameter of the rivet hole.
B = bearing value of the plate.
l = distance from center of rivet to the edge of the plate.
b = diagonal pitch.
e = efficiency of the joint.
n = number of rows of rivets.

The value of some of the above letters are as follows:

S = 0.75 to 0.80 of the tensile strength of the plate, for a rivet in single shear, a rivet in double shear is taken as 1¾ times one in single shear.*

f = 6, for cylinders of moderately good materials and workmanship. The following additions should be made for structural defects when they exist, *viz.*, an addition of 0.25 when the rivets are not good and fair in the girth seams; 0.50 if the rivets are not good and fair in the longitudinal seams; 1.00 if the seams are single riveted; and 2.00 when the quality of materials or workmanship is doubtful or unsatisfactory.

T = for steel plates about 55,000 to 60,000 pounds per square inch; for wrought iron about 45,000 pounds per square inch.†

$B = \dfrac{3T}{2}$ for ordinary bearing, and, $2T$ for web bearing.

If the thickness, t, of the plate is known

$$d = \frac{\sqrt{t \times 92}}{8} + \frac{1}{16} \text{ to be taken to the nearest 16th.} \qquad (1)$$

$$p = \frac{d^2 \times .7854 \times S \times n}{t \times T} + d \qquad (2)$$

A riveted joint is twice as strong against circumferential rupture as against longitudinal rupture. Therefore, a cylinder which requires a double riveted lap joint for the longitudinal seams will only require a single riveted lap joint of the same diameter and pitch for the circular seams, etc.

$$P = 6aD \qquad (3)$$

Now choose a trial value, d, for the diameter of the rivet hole; commercial rivets vary by 1/16 inch up to ⅞ inch, more commonly by ½ inch, ⅝ inch, ¾ inch; ⅞ inch and 1 inch being the most frequently used. Remember that the cold rivet is 1/16 inch diameter less than the hole, and that the diameter of the hole must be greater than the thickness of the plate, otherwise the punch will not be likely to endure the work of punching.

Substitute the chosen value of d in the following equations until the proper pitch is found. Six diameters of the rivet is the maximum pitch for proper calking owing to the liability of the plates to pucker up when being calked.

$$p = \frac{9.4248d^2S}{Pf} \qquad (4)$$

for single riveted lap joints.

$$p = \frac{18.8496d^2S}{Pf} \qquad (5)$$

for double riveted lap joints and single riveted butt joints with two cover plates.

$$p = \frac{37.6992d^2S}{Pf} \qquad (6)$$

for double riveted butt joints with two cover plates.

Notice that twice the result found by (4) is equal to the result found by (5), and that four times the result found by (4) is equal to the result found by (6).

Having now the pitch and diameter of the rivet, try the percentage of strength, or efficiency, of the plate, by.

$$e = \frac{p - d}{p} \qquad (7)$$

and if the result is not satisfactory try a new diameter of rivet and find its corresponding pitch as before.

The strength or efficiency of a well designed single riveted joint may be 56 per cent, of a double riveted joint 70 per cent, and of a triple riveted joint 80 per cent of that of the solid plate.

In determining the pitch of rivets and the efficiency of joints with punched holes the larger diameter of the punched hole should be used in determining the efficiency, and the smaller diameter or the diameter of the rivet should be used in determining the bearing value, etc., of the rivet.

$$t = \frac{f \times P \times p}{12 \times T(p - d)} \qquad (8)$$

Now check the pitch, diameter and thickness by substituting these values in (2).

If the rivet fills the hole and is well driven there is no bending moment exerted on it unless it passes through several plates. Practical tests have shown that rivets cannot be made to surely fill the holes if the combined thickness of plates exceeds 5 diameters of the rivets.

Butt joints are generally used for plates over ½ inch in thickness. Where one cover plate is used on a butt joint its thickness is 1⅛ times the thickness of the plate. Where two cover plates are used each should be about ⅝ of the plate thickness.

Now check the diameter, thickness and pitch for crushing by

$$\frac{12dtB}{P} = \text{or} > Pf \qquad (9)$$

for single riveted joint.

$$\frac{24dtB}{P} = \text{or} > Pf \qquad (10)$$

for double riveted joint.

The distance from the center of the rivet to the edge of the plate after being beveled for calking should be $1\frac{1}{2}d + \frac{1}{8}$ inch. Check by

$$l = \frac{fPp}{24tS} \qquad (11)$$

and if the result is greater than $1\frac{1}{2}d$, use it, adding ⅛ inch.

The diagonal pitch of rivet of a seam having several rows of rivets all of the same pitch is generally equal to .75 to .80 of the straight pitch and should not be less than

$$b = \frac{(p \times 6) + (\text{dia. of rivet} \times 4)}{10} \qquad (12)$$

Diagonal Seams.

The ratio of strength, R, of an inclined or diagonal seam to that of a straight seam, or ordinary longitudinal seam, may be found by

$$R = \frac{2}{\sqrt{\text{cos of angle of inclination} \times 3 + 1}} \qquad (13)$$

Rivet Material.

It is necessary to make the rivets of the same material as the plates to prevent corrosive wasting from galvanic action. That is, iron rivets should be used with iron plates, steel rivets with steel plates, and copper rivets for copper plates.

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*As the rivets of a joint are protected from deterioration while the plates are thinned by wear, the shearing strength of a rivet is frequently taken as equal to the tensile strength. Also, in determining the shearing value of a rivet from the tensile strength of the plates, if iron rivets are being used with steel plates, the shearing value of the rivet must be determined from the tensile strength of iron as given above and not from the tensile strength of steel.

†The tensile strength of wrought iron plates across the grain is on an average 10 per cent. less than along the grain.

Elastic Limit of Riveted Joints of Steam Boilers.

The riveted seams of a steam boiler should cease to be steam tight for some time before the internal pressure is equal to the elastic limits of the plate. If a boiler were stretched beyond the elastic limit of the material, the rivet holes would become stretched and the joints of the plates would be disturbed, resulting in large leakage from the rivet holes and seams.

The elastic limit of riveted joints of wrought iron and mild steel is as follows:

Best quality of mild steel, 32,000 to 34,000 pounds per square inch.

Ordinary quality of mild steel, 28,000 to 30,000 pounds per square inch.

Best quality of wrought iron, 24,000 to 26,000 pounds per square inch.

Ordinary quality of wrought iron, 20,000 to 22,000 pounds per square inch.

Weight of Seams or Riveted Joints of Cylinders.

The weight of seams of cylinders varies according to their proportions and must be calculated in each particular case. A rough approximation of the weight of riveted seams may, however, be obtained by increasing the weight of the cylinder by 1-6 if formed with single riveted circumferential seams and double riveted longitudinal seams; and by 1-5 if formed with double riveted circumferential seams and triple riveted longitudinal seams.

Gripping Power of Rivets.

When two plates are fastened together by properly proportioned and well closed rivets, the frictional adhesion of the plates depends upon the longitudinal tension of the rivets. The adhesion of the plates or their resistance to sliding, per square inch of sectional area of the rivets is in a general way equal to 2-9 of the ultimate tensile strength of the rivet.

Punched Holes.

The distressing effect on the plate due to punching may generally be neutralized by removing an annulus 1/8 inch in width around the rivet hole with a reamer.

All rivet holes shall be so accurately spaced and punched that when several parts are assembled together, a rivet 1-16 inch less in diameter than the hole can generally be entered hot into any hole.

In the better class of plate work it is now the practice to drill rivet holes in plates after the plates are in place, so that the holes are sure to be fair. In some cases the holes are punched to a smaller diameter and then drilled out to final size after the plates are in place. In either case the plates are afterwards separated and the burr left by the drill removed.

The effect of clearance between the punch and die is to produce a conical hole in the plate. The punched plates are generally arranged with the large ends of the holes outside or the small ends together.

* * *

RECENT ADVANCES IN FINE MEASUREMENT.*

The limit of fineness of mechanical measurement at present attainable with absolute certainty, by the use of the most accurate micrometer microscopes or thickness measurers, fundamentally dependent on the accurate cutting of excessively fine screws, is the thousandth part of a millimeter or the twenty-five-thousandth part of an inch. The celebrated mechanical measuring machine of the late Sir Joseph Whitworth, dependent on a fine screw and on the delicacy of the sense of touch, reads directly to the ten-thousandth part of an inch. Sir Joseph Whitworth did, indeed, succeed in constructing a mechanical measurer, for the accurate determination of the length of the standard yard, which read to a millionth of an inch. But grave errors rapidly develop in such machines with the wear of the several screws employed, and a grain of dust is fatal to the trustworthiness of the sense of touch beyond the limit of the ordinary Whitworth machine just referred to. Hence, the twenty-five-thousandth of an inch may be taken as the limit of measurement of mechanical measurers of general application.

But we possess a physical means of measurement three hundred times more refined than this and free from the difficulties alluded to; that is, one which enables us to determine variations in length, thickness, or position with absolute accuracy to the eight-millionth part of an inch, or one three-hundred-thousandth of a millimeter. The foundation of this truly wonderful scale is the wave-length of light, a quantity which is now known with great accuracy for the most important lines of the spectrum.

Moreover, the method is rendered æsthetically beautiful by the fact that an actually visible scale can be produced, composed of black interference bands on a brilliant back-ground of pure monochromatic light. Further, the interval between any two bands can be subdivided into one hundred parts by employing a micrometer eyepiece on the observing telescope.

To produce the bands the monochromatic light requires to be reflected from two surfaces, almost, but not quite, in contact, one of which must be of transparent material. They must be arranged so that the intervening film of air is slightly wedgeshaped instead of being of uniform thickness, the amount of tilt of one surface with respect to the other determining the width of the bands. The value of such a scale for measuring purposes will be at once apparent when it is pointed out that if one of the reflecting surfaces approaches to or recedes from the other the interference bands also move, at right angles to their length, and that the passage of any two consecutive bands over a reference mark corresponds to a movement of the surface referred to equal to half the wave-length of the light employed. Hence, it only remains to count the number of interference bands which pass the reference mark, and to use the micrometer to determine any initial and final fractions of a band, in order to obtain the measure of the amount of motion of the surface.

This principle was first applied by Fizeau for the determination of the expansion by heat of solid substances. It has the inestimable advantage, in the case of costly or rare substances, of only requiring a small quantity of the material under investigation, a cube of one centimeter edge being ample. The principle was subsequently extended by Koch to the determination of the elasticity of thin plates.

* Dr. A. E. H. Hutton in *Times Engineering Supplement*, Oct. 18, 1905.

* * *

BOILER TROUBLE DUE TO FAULTY DESIGN.

In a paper on some steam boiler troubles read by Mr. Horace See before the November meeting of the Society of Naval Architects and Marine Engineers held in New York, reference was made to the cracking of sheets experienced in a set of plain cylindrical boilers of the form shown in Fig. 1, having mud drums, *B*, connected thereto by short tubes, *C*. These boilers were arranged to receive gases from a blast furnace, or could be fired in their own furnaces at the front end as the occasion required. The mud drums gave trouble, not as might be expected at the juncture of hats or tubes, *C*, but at the top

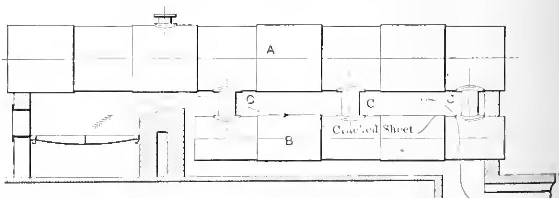


Fig. 1

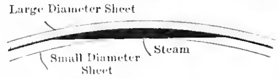


Fig. 2

of the larger diameter courses in the mud drums. The reason for this was simply that these courses, being larger diameter than the courses connected by the tubes to the boiler, trapped a small quantity of steam, about one-fourth inch in depth, as indicated in Fig. 2. The mud drum sheets above the steam, of course, became highly heated and eventually cracked; the remedy was simply to connect the larger courses of the mud drums to the boiler with additional tubes.

* * *

Chrome nickel steel is now made which with special heat treatment, has a tensile strength of 250,000 pounds per square inch of section, an elastic limit of 230,000 pounds, an elongation of 11.5 per cent, and a reduction of area of 35 per cent.

MILLING CUTTERS.

"A."

There are probably no tools more universally used in the modern machine shop than milling cutters; and no tools have to such an extent revolutionized machine shop practice during the past ten or fifteen years as have milling cutters and milling machines. Not only are they to a great extent doing work formerly done on planers, shapers, gear planing machines, slotting machines, etc., but during the last three or four years all up-to-date machine shops have been more and more abandoning the practice of using the lathe for thread cutting, and

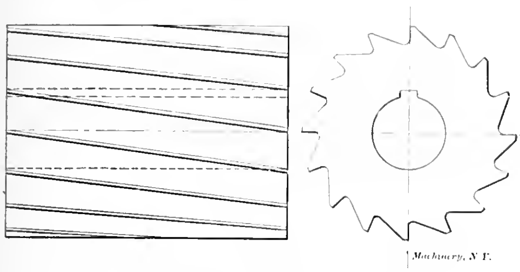


Fig. 1. Plain Milling Cutters with Spiral Teeth.

in its place using the thread milling machine. Owing to the great variety of work done, and to the wide difference between the operations performed by milling cutters, these tools are made in such an enormous number of different styles, kinds, and forms, that it would be impossible to treat them all under a general heading. For this reason each of the more commonly used kinds of milling cutters will be treated separately in the following article.

Plain Milling Cutters.

Plain milling cutters are generally manufactured in sizes varying from two to five inches in diameter and up to six inches in length. However, the writer would not advise the use of solid, plain milling cutters with a width of face greater than four inches. When a width of face of more than four inches is required, it is advisable to make such cutters in two or more interlocking sections (the various styles of interlock will be treated later).

TABLE 1. NUMBER OF TEETH AND AMOUNT OF SPIRAL OF PLAIN MILLING CUTTERS.

$$\text{No. of teeth} = \frac{5 \times \text{diam.} + 24}{2}$$

Diameter of Cutter.	Number of Teeth.	Spiral = 9 × diameter + 4.
2	16	One turn of spiral in 22 inches
2¼	18	" " " " " 24¼ "
2½	18	" " " " " 26½ "
2¾	18	" " " " " 28¾ "
3	20	" " " " " 31 "
3½	20	" " " " " 35½ "
4	22	" " " " " 40 "
4½	24	" " " " " 44½ "
5	24	" " " " " 49 "
5½	26	" " " " " 53½ "
6	26	" " " " " 58 "
6½	28	" " " " " 62½ "
7	30	" " " " " 67 "
7½	30	" " " " " 71½ "
8	32	" " " " " 76 "
9	34	" " " " " 85 "
10	36	" " " " " 94 "

There are two very strong reasons why not only the manufacturer but also the user should prefer wide face cutters to be made in sections. In the first place the difficulty and the risk taken by the manufacturer in the various operations in making a cutter of very large dimensions, owing to the liability of such cutters cracking in hardening, ought to be sufficient to induce him to try to discourage his customers from using such cutters solid. In the second place the risk taken by the buyer is greater than when using a solid cutter, because if anything should happen to the cutter the whole cutter would have to be replaced; whereas, if made in sections only the injured section would need to be replaced, and the buyer will find that the extra cost of having the cutters made in interlocking sections will be greatly overbalanced by the saving it will give him.

Referring to the limit of diameter (five inches) given above, this is, of course, only arbitrary and cutters of much larger diameter are often made solid. It must be remarked, however, that cutters of larger than five inches in diameter ought to be made with tool steel blades inserted into a body made out of machine steel or cast iron. When making a cutter in this manner it will even be cheaper to have high speed steel blades inserted in a steel or cast iron body than to make the cutter solid out of common, ordinary tool steel. It must also be remembered that when a cutter of this kind is worn out, the blades only will have to be replaced.

In regard to the teeth in plain milling cutters, it is obvious that a solid cutter will have a greater number of teeth than one with inserted blades, as in the latter kind; of course, some space is required for some fastening device for the blades.

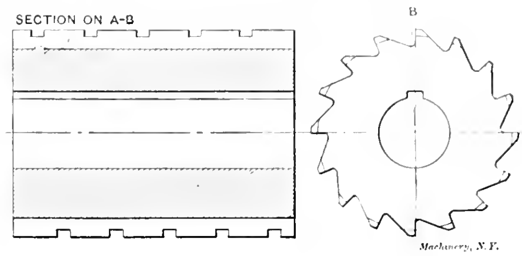


Fig. 2. Plain Milling Cutter with Notched Teeth.

In table 1 will be found the proper numbers of teeth to be used for different diameter cutters. These numbers of teeth can approximately be found from the formula

$$N = \frac{5D + 24}{2}$$

in which N designates the number of the teeth and D the diameter of the cutter. The teeth of plain milling cutters are usually cut spiral. The amount of spiral is also given in Table 1.

Although all cutters ought to be cut spiral, whatever the width of face, it has become a practice to cut the smaller sizes (up to ¾ or 1 inch width of face) straight. Some users even prefer to have all cutters, no matter what width of face, cut straight, but in order to break up the length of the cut, small grooves are cut at proper intervals in the land of each

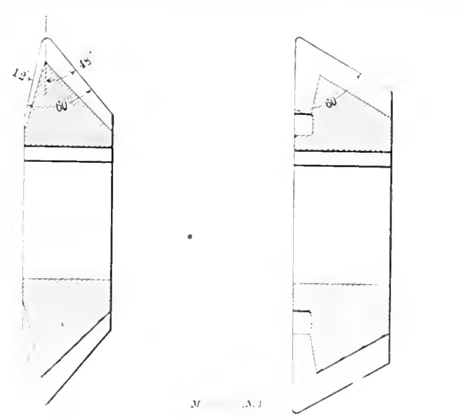


Fig. 3 Fig. 4

Cutters used in Fluting Spiral and Straight Tooth Cutters

tooth. The grooves in one tooth should come in the center of the cutting portion between two grooves in the next tooth. (See Fig. 2.) Cutters made in this manner are generally termed "Cutters with nicked cutting edges." Some users of plain milling cutters insist on having the cutters nicked, even though the teeth are cut spiral, and when the face of the cutter is wide, it is certainly to be recommended.

Plain milling cutters with the teeth cut spiral should be

fluted with a cutter having 60 degrees included angle; 12 degrees on one side and 48 degrees on the other, as in Fig. 3. Some manufacturers, if not all, advertise cutters for fluting spiral mills having an inclusive angle of 52 degrees; 12 degrees on one side and 40 degrees on the other. This, however, makes a rather weak and unsupported tooth. When teeth are cut straight a 60-degree angular cutter should be used, as in Fig. 4.

The relief to give the teeth of a cutter, when grinding, is of main importance. In the first place, it must be remembered that a very different relief will be the result when using a grinding wheel of the disk form than when using one of the cup wheel forms.

A glance at Fig. 5 where both reliefs are shown in exaggerated proportions, will instantly convince the reader that

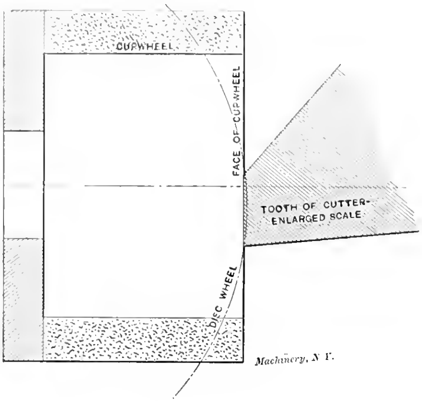


Fig. 5. Effect of Grinding with Disk and with Cup Wheels.

the relief obtained by the cup wheel (the flat relief) is the proper and preferable relief to give to the teeth, as this form will not only strengthen the teeth, but also provide a better cutting edge. The angle of the relief should vary between five

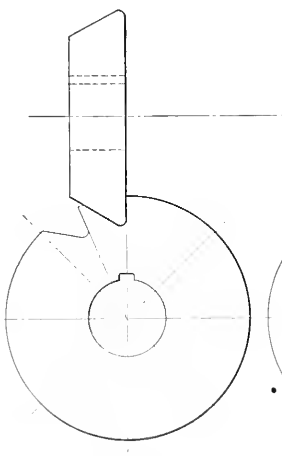


Fig. 6. Cutting Teeth with no Front Rake.

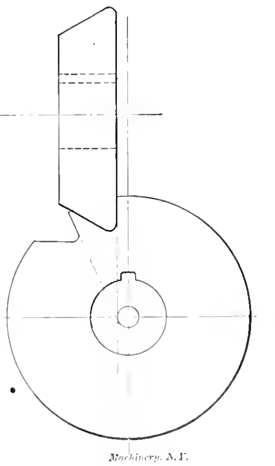
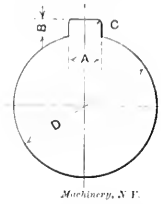


Fig. 7. Cutting Teeth with Front Rake.

and seven degrees. Another thing that always ought to be observed, but which is often overlooked, is that the front face of the tooth should not always be in line with the center of the cutter, but have a certain amount of front rake, the amount of which ought to be governed by the kind of material the cutters are to be used upon and the way in which they are presented to the work. (Figs. 6 and 7.)

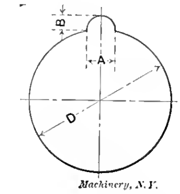
When making plain milling cutters in general, it always ought to be observed that enough metal is allowed between the bottom of the flute and the hole; not, however, forgetting the keyway opposite, where the cutter will naturally be most liable to break. Manufacturers are trying to establish a standard for square as well as half-round keyways which, if adopted by all users, would certainly save much confusion and add to the interchangeability of the cutters. These proposed standards are given in Tables 2 and 3.

TABLE 2. STANDARD KEYWAYS FOR MILLING CUTTERS.—SQUARE.



D = Diam. of Hole.	A = Width of Keyway.	B = Depth of Keyway.	C = Radius of Corners.
$\frac{3}{8}$ to $\frac{9}{16}$ inch.	$\frac{3}{32}$	$\frac{3}{64}$	.020
$\frac{5}{8}$ to $\frac{7}{8}$ "	$\frac{1}{8}$	$\frac{1}{16}$	.030
$\frac{15}{16}$ to $1\frac{1}{8}$ "	$\frac{5}{32}$	$\frac{5}{64}$	.035
$1\frac{3}{16}$ to $1\frac{3}{8}$ "	$\frac{3}{16}$	$\frac{3}{32}$	.040
$1\frac{7}{16}$ to $1\frac{3}{4}$ "	$\frac{1}{4}$	$\frac{1}{8}$	.050
$1\frac{13}{16}$ to 2 "	$\frac{5}{16}$	$\frac{5}{32}$	.060
$2\frac{1}{16}$ to $2\frac{1}{2}$ "	$\frac{3}{8}$	$\frac{3}{16}$	.060
$2\frac{9}{16}$ to 3 "	$\frac{7}{16}$	$\frac{3}{16}$	.060

TABLE 3. STANDARD KEYWAYS FOR MILLING CUTTERS.—HALFROUND



D = Diam. of Hole.	A = Width of Keyway.	B = Depth of Keyway.
$\frac{3}{8}$ to $\frac{5}{8}$ inch.	$\frac{1}{8}$	$\frac{1}{16}$
$\frac{11}{16}$ to $\frac{13}{16}$ "	$\frac{3}{16}$	$\frac{3}{32}$
$\frac{7}{8}$ to $1\frac{3}{16}$ "	$\frac{1}{4}$	$\frac{1}{8}$
$1\frac{1}{4}$ to $1\frac{7}{16}$ "	$\frac{5}{16}$	$\frac{5}{32}$
$1\frac{1}{2}$ to 2 "	$\frac{3}{8}$	$\frac{3}{16}$
$2\frac{1}{16}$ to $2\frac{7}{16}$ "	$\frac{7}{16}$	$\frac{7}{32}$
$2\frac{1}{2}$ to 3 "	$\frac{1}{2}$	$\frac{1}{4}$

Side Milling Cutters.

Next in importance to plain milling cutters, no doubt, are side or straddle milling cutters, the latter name having originated through the use of these cutters in pairs or gangs. These cutters can be considered as a combination of a face milling cutter and an end mill and consequently as far as the face is concerned, whatever has been said about plain milling cutters applies also to side milling cutters. As these cutters are very seldom made of any considerable width of face, they are almost always cut straight.

When milling the teeth on the sides of a side milling cutter, the cutter to use and the angle to which to set over the mill when being cut must be selected with a great degree of judgment and care. It would be almost impossible to give any definite rules or figures, but for guidance, however, it may be said that a cutter of the same form as for milling the teeth on

TABLE 4. NUMBER OF TEETH IN SIDE MILLING CUTTERS.

No. of teeth = 3.1 diam. + 11.

Diameter of Cutter.	Number of Teeth.	Diameter of Cutter.	Number of Teeth.
2	18	$5\frac{1}{2}$	28
$2\frac{1}{4}$	18	6	30
$2\frac{1}{2}$	18	$6\frac{1}{2}$	32
$2\frac{3}{4}$	20	7	32
3	20	$7\frac{1}{2}$	34
$3\frac{1}{2}$	22	8	36
4	24	9	38
$4\frac{1}{2}$	24	10	42
5	26	...	..

the face should be used except that the angle of the cutter should be about 75 degrees instead of 60 degrees. As some readers may be enough interested in the question to wish to get as definite information as possible, and as it is hardly within the scope of this article to go into such close details, the writer would refer those particularly interested to an article by Mr. Porter in MACHINERY for April, 1904.

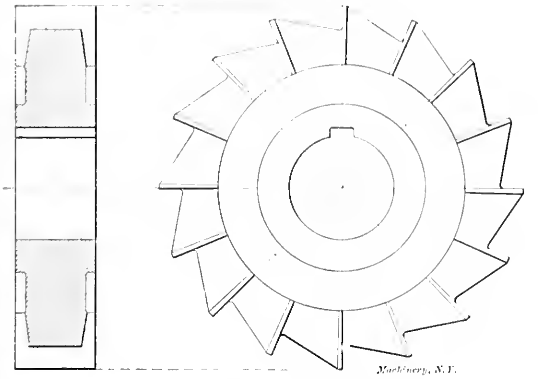


Fig. 8. Cross-section of Side Milling Cutter.

In regard to the number of the teeth, Table 4 gives the number of teeth that straddle milling cutters of different diameters ought to have. The number of teeth is found approximately from the formula

$$N = 3.1D + 11,$$

N indicating the number of teeth and D the diameter of the cutter. What has been said about the relief on plain milling cutters will also apply to the relief on the face of the teeth of straddle milling cutters. The relief on the side of these cutters, however, does not need to be as large as on the face of the teeth. The reason for this is very obvious if one considers the difference in the relationship of the tooth to the surface to be cut, when this tooth is located on a circular and on a plain

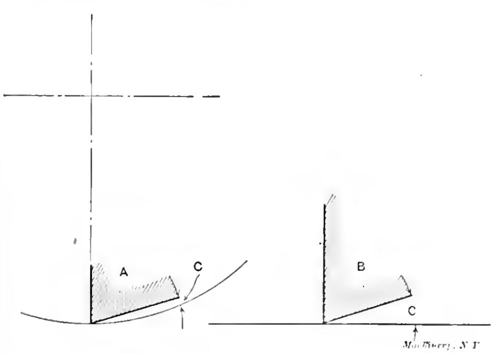


Fig. 9. Peripheral and Side Relief Compared.

surface. Referring to the cut, Fig. 9, where the case is shown in exaggerated scale, it is easily seen that if the same angle of relief is given to the tooth A on a circular surface and to the tooth B on a flat surface (the side of the cutter), the actual relief of C will be considerably larger on the tooth B and will be larger than the relief on the tooth A according to the diameter of the circle on which the tooth A is located. The same angle of relief gives a smaller actual relief C on a smaller diameter than on a large one.

Even not considering this theoretically, there are practical reasons why the relief on the sides does not need to be as large as on the face; in fact, the main reason why a side milling cutter is preferable to a narrow, plain milling cutter for cutting slots is that the former has more chip room on the sides because of having teeth and consequently will permit chip room, thus making the sides of the slot smoother, while, when using the plain milling cutter, the chips will clog between the sides of the cutter and the sides of the slot, producing rough places in the work. Of course, anyone using these cutters will know that the face of a side milling cutter is actually doing all the cutting which is easily seen from the fact that these cutters have to be ground more often on the face than on the sides.

Now someone might infer that no relief on the sides is necessary at all if the teeth on the sides are not doing any actual work. However, there are occasions when these cutters will have to do actual work and that is when no other cutter than a side milling cutter with the teeth relieved on the sides will produce desirable results, as for example, when an absolutely straight slot is required to be cut. When cutting a slot a plain milling cutter will never cut its way straight through the work, because when once out of the straight line it has no means of correcting its path, but must follow the direction in which it started to cut, whereas a straddle milling cutter with its teeth relieved on the sides will, even if started wrong, have an opportunity of correcting its path by being able to cut with its sides. It may be said that if the cutter or cutter arbor is running out, the slot will obviously be wider than the

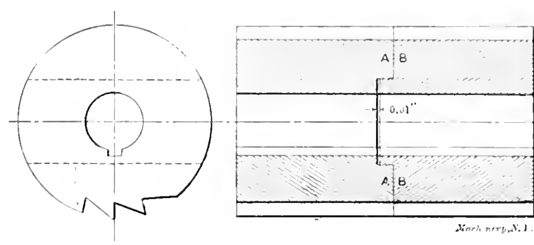


Fig. 10. Tongued Interlocking Cutters.

cutter, but the slot will in all cases be straight. In this connection it is appropriate to mention various ways of making cutters that will maintain standard widths. This is accomplished by interlocking the cutters in such a manner as to permit adjustment when having been reduced in width by grinding on the sides or through wear. There are three different ways of interlocking cutters in common use, viz.: (1) A straight slot through the center across one end of one cutter and a corresponding tongue on one end of the other cutter fitting loosely in the slot. (Fig. 10.) (2) Two or more sectors on one end of each of the two cutters cut away in such a manner that the remaining high sectors in the one cutter fit loosely into the spaces cut away in the other cutter. (Fig. 11.) (3) Opposite every other tooth on one side of each of the two cutters is cut away a portion leaving a space into which the high portions of each of the cutters fit. (Fig. 12.)

Referring to the first kind of interlock mentioned, it must be remarked that this interlock is poorly adapted for maintaining a standard width and is mostly used where cutters of unusual

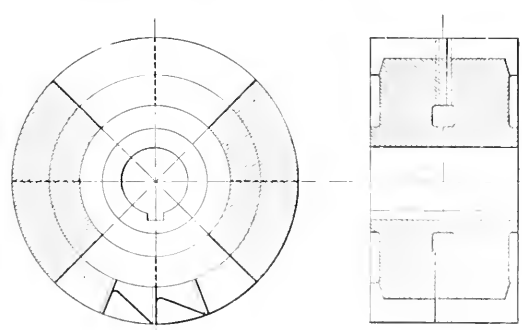


Fig. 11. Cutters with Interlocking Sectors

lengths are required which would be, if not entirely impossible, at least impractical to make in one piece. This interlock is to be recommended for such purposes because of its being very simple and inexpensive to make. It will be noticed from the cut that there ought to be a clearance of .010 inch between the bottom of the slot in one cutter and the top of the tongue in the other cutter, thus giving a resting surface between the two cutters at A and B, which faces ought

to be ground. It might also be remarked that between the sides of the slot and the tongue there does not need to be a perfect fit and consequently these sides do not need to be ground. As inferred above, this kind of interlock is not to be recommended for maintaining a standard width, although it could be used for such a purpose by inserting thin pieces between the ground faces *A* and *B*. For maintaining a standard width interlocks Figs. 11 and 12 are to be recommended. In these cases the cutters are provided with ground hubs, the width being maintained by inserting thin washers between these hubs. Between the hubs and the interlocking sections of the cutters there should be a recess of sufficient width and depth to permit clearance for milling cutters when milling cut sections so as not to cut into the hubs.

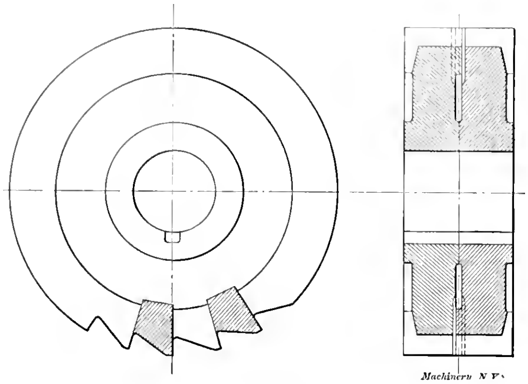


Fig. 12. Cutters with Interlocking Teeth.

There should always be taken into consideration amongst other things what material the cutter is to be used upon. For example, it would not be right to mill a cutter in the same manner and with the same number of teeth for material as widely different as copper and steel. The tables of number of teeth in cutters refer to cutters for steel and cast iron only. Cutters for such materials as brass, bronze, copper, etc., should in all cases be made with coarser teeth and cut with negative front rake. A very important thing to be remembered when milling the teeth of these cutters is that the cutter used for this operation is provided with an ample round between its angular faces so as not to produce a sharp corner in the bottom of the teeth in the cutter to be milled. Through this the liability of the cutters cracking when hardening will be to a great extent eliminated.

* * *

PAPER SCALES.

FRANK B. KLEINHANS.

Although one scarcely sees paper scales used to any great extent, there is nothing made for the use of the draftsman or designer which is more convenient. The scales which are referred to are made similar to the illustration, Fig. 1. The "Universal" brand of paper makes an excellent scale, and can readily be made by any ordinary draftsman. Draw two paral-

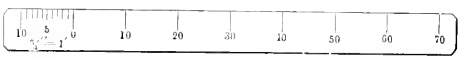


Fig. 1. Draftsman's Paper Scale.

lel lines about 5/8 inch apart for the width of the scale; pencil out the divisions from a standard scale and check up these divisions to be sure that they are correct. A scale about 9 to 12 inches in length is very convenient, although the length can be made to suit one's taste. Having penciled out the scale, and made sure that everything is correct, ink in the divisions with fine sharp lines and print on the figures. Then mark the size of the scale in one corner. After any other information has been printed on the scale, coat the top and the bottom of the scale with white shellac.

It is convenient to have these scales made up for all practicable scales, so one can readily pick out the scale desired; also in drawing out work to different scales, it will be found convenient to use one scale to correspond with the scale of the regular drawing and then another to correspond with the scale of the new drawing.

In taking dimensions from these paper scales with the dividers the following method should be used in order to avoid cutting and marring the divisions. The common method for taking off dimensions from a scale by applying the divider to

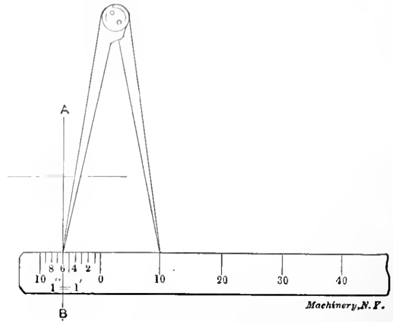


Fig. 2. Transferring Measurements without Injuring Scale.

the scale, soon spoils the divisions, and of course the dividers cannot be set very accurately after this. Fig. 2 shows a quick and easy way of obtaining any dimensions from the scale without touching the scale itself. *A B* represents a line anywhere on the drawing. Let us say that we wish the dividers set to 16 inches. We place the 16-inch mark over the line so as to correspond with the divisions on the scale, and then with one leg of the dividers prick off the distance opposite the dimension shown. We now support the dividers on this leg, remove the paper scale and open up the dividers to the line *A B;* this gives accurate dimensions and of course does not mar the scale. In using the dividers for transferring the dimensions, etc., the joints should be adjusted so that the

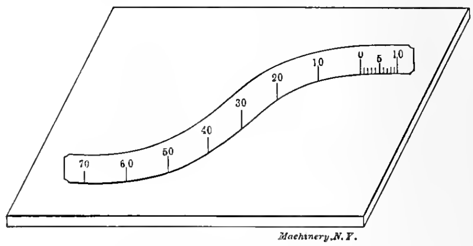


Fig. 3. Measuring the Length of Curves.

dividers will work freely; then by being light on the instrument, very accurate dimensions can be transferred.

Fig. 3 shows another advantage to be obtained by the use of paper scales. In figuring weights one must often obtain the length of irregular curved lines. The scale can be bent to conform to the neutral line of the curve, and thus the length can readily be obtained. Another advantage in the use of the paper scale is shown in Fig. 4. There is scarcely a time when the drawing board does not have several triangles, T-squares, lead pencils, drawing instruments, etc., scattered all over it. To use an ordinary wood or metallic scale on such a board is to clean everything out of the way. The convenience with which a paper scale can be used on similar circumstances is shown in Fig. 4.

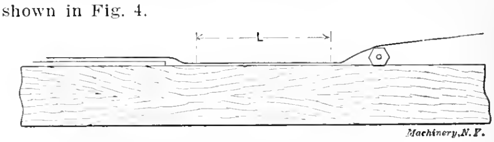


Fig. 4. The Advantages of Fexibility.

In reference to the divisions, many factories are now adopting scales up to 100 inches, and a scale divided into tenths has all the advantages of the decimal system. The last division is the only one that needs to be subdivided into inches. Of course this scale can also be divided into feet and inches as well as being divided into decimals as shown.

THE MACHINE SHOPS OF PRATT INSTITUTE.

There are at least two ways of regarding the function of the machine shop in technical training. From one point of view it is a "shop" in the strictest sense, where the student is taught the principles of an already well developed art—the art of making machine parts and assembling them into the finished product with commercial accuracy and speed. On the other hand, the student may be taught to approach the lathe or planer as he does the testing machine, not to learn how to perform the greatest number of operations in a given time with the required degree of accuracy, but to learn the properties of the various materials used in construction and the laws which determine their action when subjected to various stresses.

This latter idea can obviously be applied only to the training of the engineer, the man who is being fitted, in part at least, for a career of research and original investigation. Instead of a "shop" then, we would have a "laboratory," and some schools have actually made this change in name, feeling work on the planer and milling machine, and to shape, harden and temper the tools used in metal working.

The Pratt Institute of Brooklyn holds, as its main object, the helping of young men and women to a higher industrial plane. This object is accomplished through day and evening classes in electrical and mechanical engineering, chemistry, art, design, social science, and many other lines where it has been demonstrated that practical instruction can be given to young men and women. With this end in view it is natural that the shop curriculum should have developed along the line of the more practical of the two tendencies discussed above, and that the equipment should be so selected and arranged as to give the best possible commercial training to the student. In the following paragraphs the writer aims to describe the equipment of these shops and the methods of instruction therein pursued, believing that such a description will be of interest to those who feel their need of more systematic training in machine shop practice, as well as to instructors actually engaged in teaching this subject.

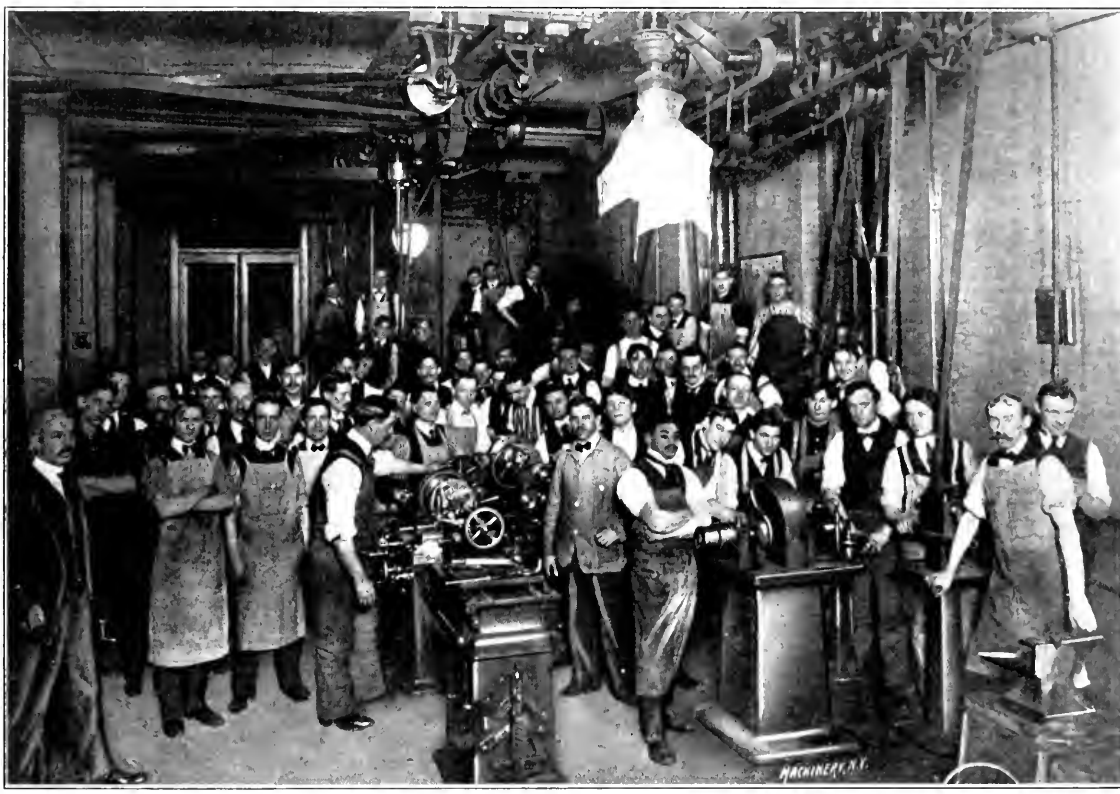


Fig. 1. The Evening Class in Machine Shop Practice, at Pratt Institute, Brooklyn.

doubtless that it expressed their ideals better than does the simpler word. In practice, however, it is doubtful if this ideal can be very closely approached; such work as that done by Dr. Nicolson and the students of the Manchester Technical School, in investigating the action of cutting tools of high-speed steels and other work of this character, would properly come under the classification of laboratory work; but there is no school which can offer the time and facilities for giving the whole student body a thorough course in work of this kind, nor perhaps would it be advisable if it were possible, since the test of the future engineer's worth will be in a large measure his ability to produce commercial results with commercial means, and the knowledge of machine shop practice as an established art must necessarily form an important part in the training of a man who expects to be concerned with the business of working metals into useful forms. Whether, then, this part of the school equipment be called a "shop" or be dignified by the term of "laboratory," the course of instruction tends more or less in the same direction; the student is taught how best to drill a hole, to cut a thread, to set up

The shops, in their present location and in over fifty per cent of their equipment, are new. They occupy two floors of an ell of the Technology Building, comprising altogether, with the office and tool room extensions in the main building, a space of about 12,000 square feet. The rooms are lofty, neatly painted in light colors, and furnished with windows on three sides and a part of the fourth. The artificial lighting is by arc lamps on the indirect reflected plan, as may be seen in the interior views Figs. 2 and 6 inclusive. Fig. 2 is a view taken on the lower floor looking down the room from the tool room end. Fig. 3 shows a view of this same room looking in an opposite direction. In Figs. 2 and 4, which are taken from the tool room end, the superior character of the machine tool equipment will be appreciated. At this end of the room are grouped three Bath grinders, a Cincinnati drill press, Bickford radial drill, Colburn boring mill, Espen-Lucas boring machine, a No. 3 Universal milling machine of the Garvin design, and a number of shapers and planers of various capacities up to 30 x 30 x 8 foot capacity. These tools are all of the most modern design. There are two enclosures at

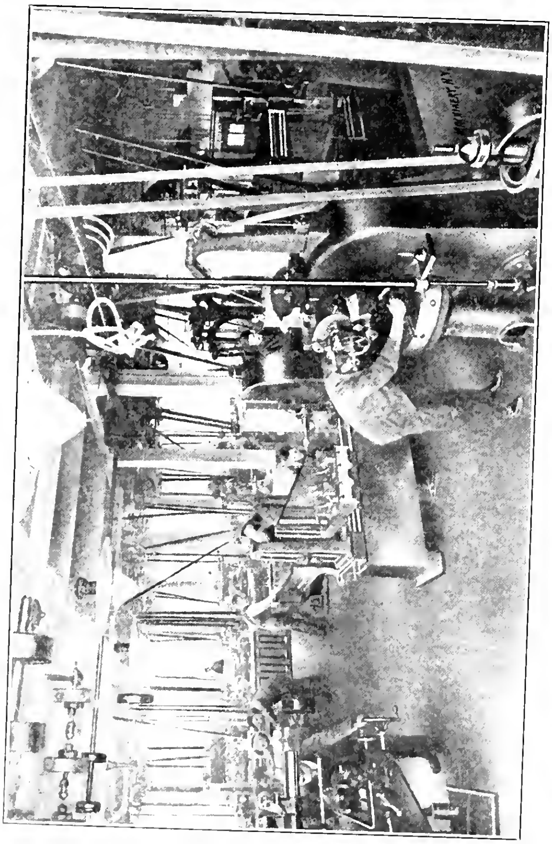


Fig. 2. The Large Tools on the Lower Floor.

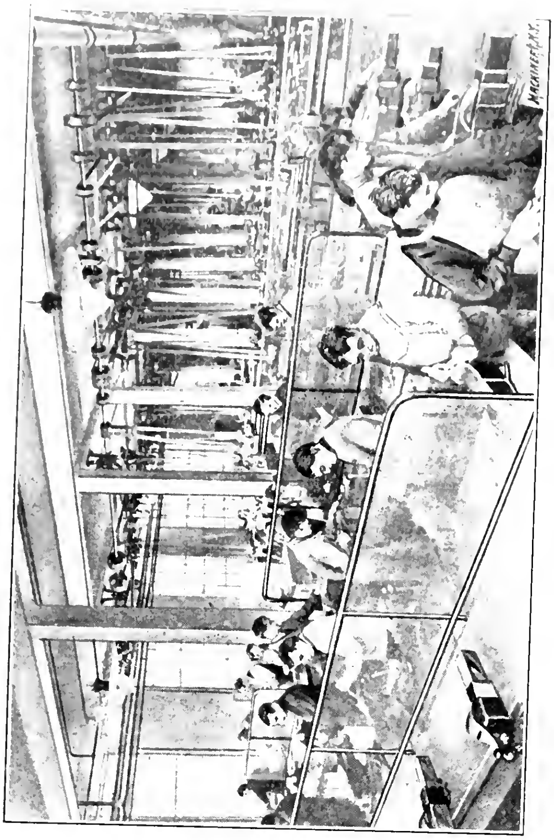


Fig. 3. The Filing and Chipping Benches.

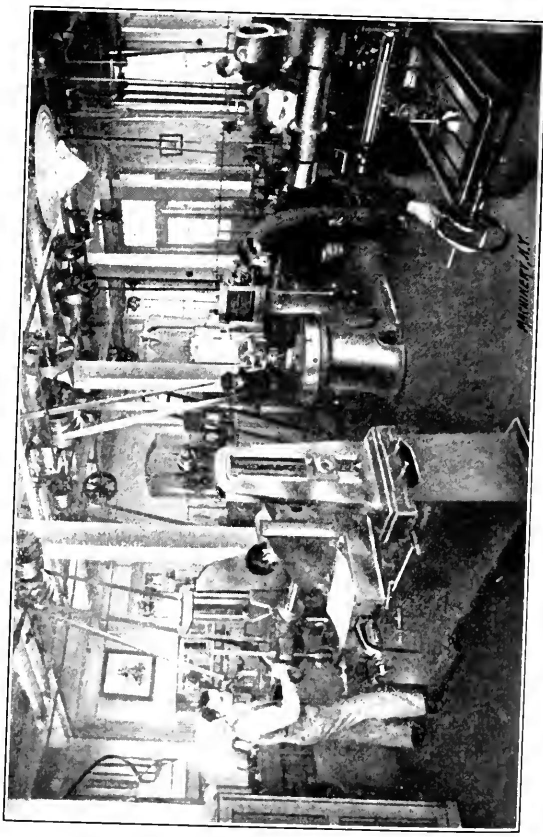


Fig. 4. Looking toward the Tool and Assembling Room in Shop No. 1.

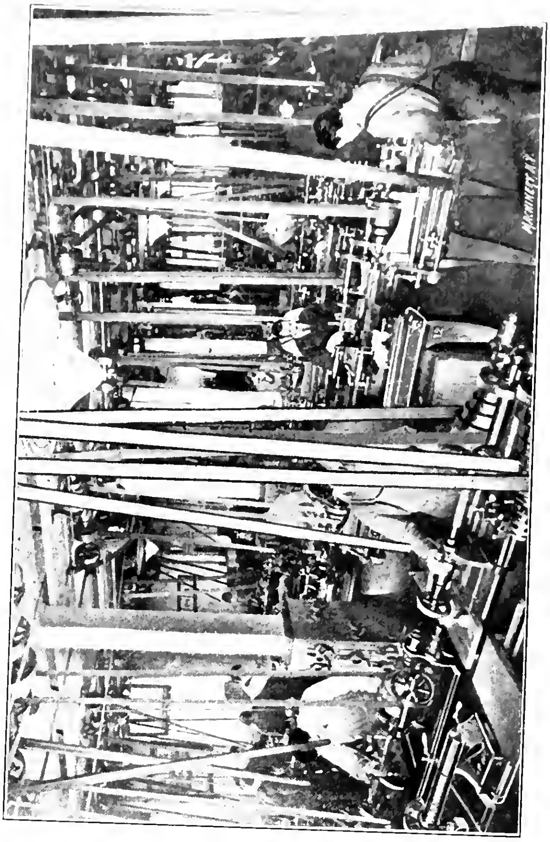


Fig. 5. The Lathe Department in Shop No. 1.

this end of the room; one of them is the assembling room, containing a universal milling machine, lathe, etc., and is devoted to tool making and the fitting and assembling of machine parts; on the other side in the tool room proper are stored the drills, milling cutters, arbors, etc., as well as the materials for the various exercises, all to be given out on check as required.

The center of the room is occupied by the lathe department. Most of these tools are also new, and include machines of the latest types with quick change gear devices, and of special design for working with high-speed steel. A group of speed lathes for the early lathe exercises and for other practical

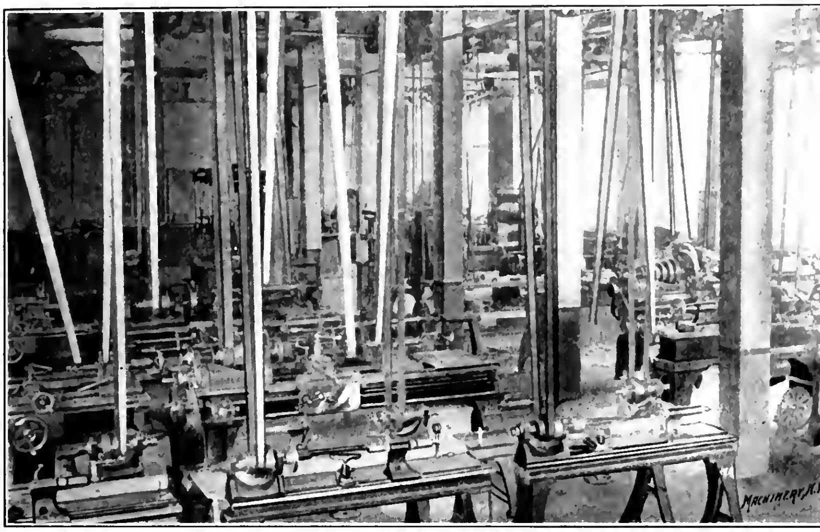


Fig. 6. A Part of the Lathe and Planer Equipment of Shop No. 2.

uses is located at the extreme end of the room as shown in Fig. 3. The filing and chipping benches are provided with screens to protect the student from the flying chips of their opposite neighbors. At one side of the room is the hardening and tempering outfit shown in Fig. 8. This comprises an open and muffle furnace, a melting pot, blow pipe table, and an oil bath, with a pressure blower and reservoir for furnishing the blast.

The upper floor also has its own tool room, with the offices of Mr. Kaup, the principal of the department, adjoining it. A view of this floor is shown in Fig. 6. There are a large number of engine lathes, speed lathes, drill presses, planers, shapers, etc., and a complete outfit of tools for use with them. There are a number of noticeable conveniences in this room and in the room downstairs as well. Wherever it is possible to put a blackboard so that it will not interfere with any of the machines, this has been done. In some cases where a blackboard was desired and was not otherwise obtainable, it has been hung on hinges to fold against the wall, opening up across one of the windows when in use. Each lathe has such wrenches and attachments provided for it as are necessary to facilitate the getting out of its work. Boards with hooks for dogs are distributed around the room and it is required that the dogs be brought back to their proper places after they have been used. The planers, shapers, milling machines and other larger tools each have their own cupboards where the various appliances necessary for their operation are kept. Cupboards are, in fact, put around the walls wherever there happens to be nothing else, the idea being to furnish all the necessary conveniences, and a place for keeping each of them as well, and the student is made to live up to the requirement that each tool shall be returned to its proper place after using. Both shops are driven by motors which receive their current from the main power plant of the school.

In the beginning of his shop work, with the first exercise, the student is taught the meaning and purpose of every movement of his body and every point in the design of the tool he uses. He is given a block of cast iron whose edges he is to bevel with a cold chisel. Mimeographed sheets of instruction are given him. In these the various shapes of chisels are described, particular attention given to the cutting angle, the shape of the stock from which it is forged, the size of the stock, and length of the chisel and the way in which it is to be held by the operator; then he is told how to grind the various forms and the proper way of holding the work. Each move is described in turn: the chalking of the rough surface, scribing of the guiding lines, and every other practical point that the experience of the instructor can suggest. The question of the proper weight of hammer and length of handle is discussed, and reasons given for choosing the weight and shape supplied to the student. The whole operation is in fact analyzed in much the same way as is done under the Taylor system of shop management, the student in these preliminary exercises being required to follow a method of procedure laid down by men experienced in the art. Furthermore, from the very start no time is wasted on useless work. The blocks whose corners are beveled in the first exercise are cast with a monogram on the top surface and are afterward finished as paper weights for use in the school; thus, instead of being merely a mechanical exercise, the work arrives at once at the dignity of productive labor. After two exercises in chipping, which are repeated by each student until he has been able to perform work in a satisfactory way, similar minute instructions are given in the art of filing; the various tools, ways of holding work, the proper way to grasp the file, and the proper movement of the arms, are all detailed, together with much useful information as to the relative value of different grades of files for different work. Scraping, planer work, turning, boring, milling, and more complicated operations are taken up in turn. In each case, in the earlier part of the student's course, he is required to follow a set method of procedure, being given definite instructions in speeds, feeds, tool grinding, and holding the work. This information is all

Fig. 7. The Hardening and Tempering Plant.

the result of direct experiments on the part of the instructors, checked by their practical commercial experience.

After this rigid preparatory course in the fundamentals of the art is completed, the student is allowed more latitude. As previously intimated a point is made of spending all the energy of the shop in productive labor exclusively. When the student has learned to handle the various tools and machines, he begins to work on any of the simpler appliances that are constantly being turned out. The larger part of the apparatus

in use in the school has been and is being made by the school shop. Constant repairs are called for, and with the growth of the institution, large quantities of new instruments are required. Students often have work of their own which they desire done, such as small motors, gas engines, or light machinery of various kinds, and in the near future simple machine tools will be built for sale in the open market.

The student is also at once introduced to something approaching the routine of shop management and system. All his time is accounted for, the tools he uses from the tool room are charged to him, the cost of the materials and labor he puts into his work is recorded, and he is put under the supervision of foremen taken from the older and more capable members of the class, who are thus given an opportunity to develop in executive ability. As time goes on, the student is finally left more or less to himself, so that the instructor has means of judging as to his capability for independent work.

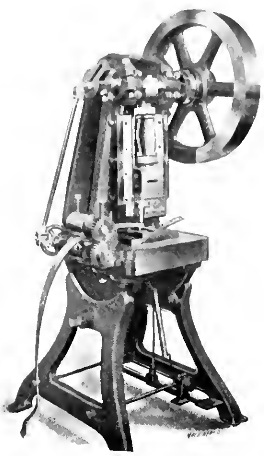


Fig. 8. A Press Built in the Shops.

Perhaps an enumeration of some of the work done by the more advanced classes will give an idea of the measure of success attained under the system of instruction pursued. Most of the small tools, such as reamers, milling cutters, taps, tap wrenches, etc., are made in the shops as fast as they are needed. The building of scientific apparatus for the various departments has already been mentioned. Such things as testing machines, micrometer calipers, microscope mountings, electric motors and dynamos, are supplied to other departments. Fig. 9 will give an idea of the die work attempted. Near the front of the group will be seen the dies used for making the brass checks used in the tool room; towards the right are some thumb tacks and the tools used for making them; at the rear of the group are the rotor and stator punchings for an induction motor, and the dies with which they were punched. The press in which this work was done, shown in Fig. 8, was built entirely by the students from patterns and

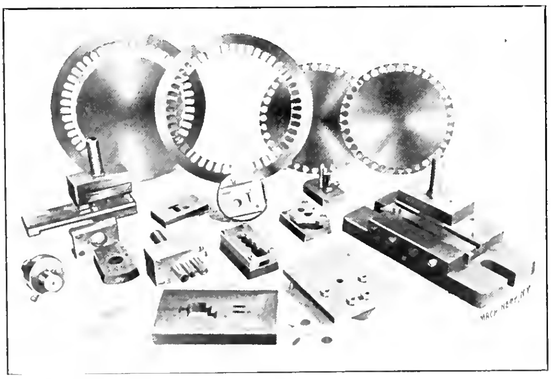


Fig. 9. Examples of Die Work done by Students.

drawings furnished by the E. W. Bliss Co. The No. 3 universal milling machine with full automatic feeds before referred to was built in the shops. Among other machines so constructed are: two turret heads; a twenty inch crank shaper; two double spindle drill presses; two tool grinders; and two 5-horse power motors. In a sense the shop may be said to be self supporting, since the product would cost, if purchased in the open market, considerably more than the raw material used and the supervision required in its production.

There are in general three classes of students who make use of the shops. The regular day classes in mechanical and electrical engineering require, the one ten hours a week for two years, and the other ten hours a week for one year in the shops. There is also directly under the supervision of Mr. Kaup, a class in machine construction and design which aims to fit the student for the position of machine designer. This takes up in turn the principles of mechanical drawing, pattern making, molding, forge work, and machine shop practice, and finally the commercial design of machinery. In this latter subject the students are allowed considerable latitude of judgment, subject to the criticism of their more experienced teachers. They can follow their work through all the stages of pattern shop, foundry and machine shop and thus get a good training in directions in which many draftsmen are deficient. Such of this machinery as possesses sufficient merit is to be manufactured and sold.

There is a third class, perhaps the most interesting of all, which meets evenings on three nights of the week. It is composed of young men who, unlike the students in the other classes, are unable to give up the daylight hours to advanced scientific study. Fig. 1, taken in the old shop, shows a group of these men. Mr. Kaup, who stands in the front at the left side of the picture, realizing that the product of the school shop is after all men, and not machinery, takes more pride in this group than in all the presses, milling machines and shapers the shops have ever built. The students are mostly engaged during the day as lathe or planer hands, or in doing other machine shop work, but many of them have never had the opportunity to get a broad and comprehensive view of the whole subject of machine shop practice. The definite instruction given them by lectures and exercises in these evening classes fits them for higher pay as workmen, and helps many of them to positions of greater responsibility. This class seems to fill a great need in this day of specialized operations, when a workman is kept doing the thing he is used to and given little chance to learn about the business as a whole. Many former students are able to trace their first steps in the upward climb to the stimulus given by the evening classes of the institute. It is an altogether inspiring sight to pass the school building on a class night and see them lighted up from the ground to the topmost story, the rooms filled with young men and women in this or other courses who are preparing themselves for greater opportunities and greater rewards than come from the occupations and stations in life they now occupy.

* * *

Notwithstanding the fact that the water composing the waves of the sea has little progressive motion, except where shallow, the popular impression is that it travels with great rapidity, and this impression is apparently confirmed by such catastrophes as occurred last October to the Cunard steamer *Campania*, the lower deck of which was washed by a "giant" wave causing the loss of five steerage passengers and the serious injury of many more. But, upon second thought, it is not surprising that tons of water, shipped by a vessel making, say, twenty miles an hour, should cause great damage and hurl human beings about like chips. The property of inertia is shared by water the same as other substances, and when a vessel lurches so that a large roller dashes water up on its decks it does not instantly acquire the speed of the vessel but is rapidly left behind, washing the decks clear of everything portable as it approaches the stern.

* * *

The persistent manner in which certain bits of information flit through the columns of trade papers reminds one of the farewell tours of certain noted actresses—they are always going, but never gone. As an example we might mention the old and very well-known trick of cutting off a gage glass without tools other than a common match which is used to mark a ring around the inside of the glass and to heat the exterior until it cracks off. When we consider the many things that are useful to the engineer or machinist but of which we never hear anything outside the shop it seems that the energies of technical papers are too often wasted in repeating such notes. On the other hand the crop of younger readers find these things new so what are we to do about it?

SIMPLE MECHANICAL DEVICES FOR REDUCING THE COST OF LABOR ON MACHINE WORK.

OSCAR E. PERRIGO.

In the presentation of mechanical devices in the pages of technical papers and magazines a noticeable feature frequently seems to be to describe and illustrate something absolutely new; something that nobody ever heard of or dreamed of, or ever would have thought of if this particular mechanic had not favored the earth with his presence at this particular time. So much does this idea often possess the mind of budding mechanical genius that the prosey, everyday, practical usefulness and consequent financial value of a device is either considerably obscured or lost sight of altogether.

Quite recently a prominent technical journal published an engraving and description of a small hand device as one of these exceedingly new and simple mechanical devices that was such a valuable addition to mechanical science that it seemed a pity no one had ever conceived of its application before. In this case the device *was* practical, valuable and useful. But it was not *new*. The writer well remembers working many weary days with it the first year of his experience in the machine shop, lo, these many moons gone by.

Another device is shown which must have been evolved by the active brain of a scientific mechanic for all its parts seem to be calculated with extreme accuracy and designed strictly according to the book, and its construction carefully following the lines laid down. It would undoubtedly do the work for which it was designed. But the expense attending its construction, the narrow limit of its application and the infrequent necessity for the use of such a device made it a financial failure.

The truly successful device, mechanically and financially, is not always, or often, the one of carefully scientific and elaborate design or intricate construction. It is more often the one of few parts, designed on well-known mechanical principles, plainly constructed, strong and durable and that *does the work quickly, correctly and economically*—that "delivers the goods." The fact that its principles are old, that this piece or that has been used long ago, or that someone else could have made it just as well, and all similar considerations don't count for much with the man who has to pay the bills. What he wants first, last and always is *results*. As to how they are brought about is a secondary matter.

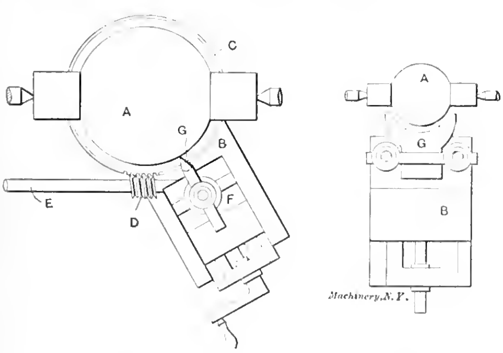


Fig. 1. Fig. 2

Two Methods of Finishing Spherical Castings.

To illustrate these facts and the results that come from simple mechanical devices, designed to meet real and practical conditions, the following devices and attachments that have been designed, built and successfully used, are presented as examples.

Referring to the engravings, Fig. 1 shows an attachment for turning the surface of spherical pieces *A*, of cast iron. A large number of these of varying diameters was required. The attachment designed for the work is here shown. It consisted of a worm gear *C*, in the form of a ring attached to the base of the compound rest *B*, of an ordinary engine lathe. Engaged in the worm gear was the worm *D*, which was operated by proper gearing, through the medium of the shaft *E*, the bolts securing the compound rest having been slightly loosened to permit it to rotate and yet tight enough to hold it firmly and prevent any chattering of the tool. In the tool block *F*, was fitted the tool *G*, which could thus be adjusted at the proper distance from the center of rotation, which was directly beneath the center of the spherical piece to be turned, so that any diameter of sphere could be turned, the tool being carried around the surface by the worm gear feed. This was a great improvement over the former method of roughing off the casting by a tool in the compound rest, operated by the hand feed and then hand-tooling to a templet. The device had its limitations and the smaller spheres were not so economically turned as the larger ones.

In consequence of this the very simple device of a "forming tool" was resorted to and arranged as shown in Fig. 2, in which *A* is the piece to be turned, *G*, a forming tool shaped exactly to the curve required and held in the tool block *B*, as shown. A different tool was, of course, made for each different diameter of sphere.

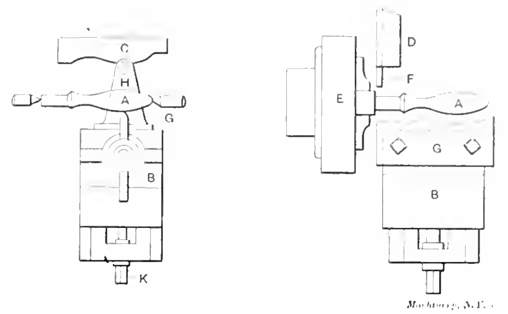


Fig. 3. Fig. 4.

Improvements in the Manufacture of Crank Handles.

The results were as follows: A sphere that would take from two to three hours to turn by the old methods, even with an expert man to hand-tool it, could be made in less than an hour by the device shown in Fig. 1, and the workmanship was much better. The device shown in Fig. 2 would finish any piece within its range in less than half an hour. The advantage of the special device is apparent and the reduction of cost easy to calculate. The device shown in Fig. 1 was later used in turning the concave and convex surfaces of step bearings for turbine water wheels, some of which were sixteen inches in diameter.

A large number of drop-forged steel handles, such as shown at *A*, Fig. 3, were to be made. The previous plan was to make a "former" *C*, having the exact contour of the handle *A*. Against this was a friction roll, pivoted upon the tool block *B*, as shown. The feed screw *K*, having been removed, the tool block *B*, could be forced forward by means of a cord and weight so as to keep the friction roll always in close contact with the former *C*, and in consequence the proper curve was made on the handle *A*, as the lathe carriage moved laterally from right to left. The workmanship was fairly good but the device was only capable of finishing drop-forged pieces that were forged nearly to the finished size.

A more expeditious method of making these handles was demanded and here again a forming tool came into use. Instead of using a drop-forged blank the handles were formed from a round bar of steel held in the chuck *E*, and the forming tool *G*, secured to the tool block *B*, by the two screws as shown, was fed against it very slowly until the entire contour was formed, when it was cut off from the bar by the cutting-off tool *F*, held in the stock *D*, moving forward from the back of the lathe. A steady-rest of proper form supported the piece at its largest part to prevent vibration as it was being turned. The results were: Very smooth work, the cost of drop forging entirely eliminated, and with the addition of an automatic feed one man could run any number of machines up to ten, while by the old process he could not properly handle more than two. As will be seen, the device was economical to construct and not liable to get out of order.

It is the practice at the present time to turn up short shafts with the various shoulders and different diameters as well as lengths in a turret lathe, the cutting tools being of a kind technically denominated "box tools." There are, however,

many of these shafts that are too long to be well handled in the usual turret lathes, and there are many shops that do not possess even the ordinary make of turret lathes. Hence these shafts must be cut from the bar in a cutting-off machine, centered and turned up in an ordinary engine lathe. Where there are several different lengths and diameters as shown on the shaft marked *A*, in Fig. 5, it is customary to set a stop for a single diameter, and another for the length up to one shoulder, and then turn up that one shoulder on all the shafts. Then the stops are set for the next shoulder and they are all handled over again, and so on until the job is completed. This is a long and laborious process, which might be much more economically performed if *all* the shoulders on one end, for instance, could be turned up without changing the tool or removing the shaft from the lathe. Figs. 5 and 6 show how one young machinist did this, and by doing the work "by the piece," more than doubled his weekly pay.

Fig. 5 is a plan of a portion of the carriage lathe *C*, the tool block *B*, and an ordinary thread gage *D*, of an engine lathe; while the same parts are represented in front elevation in Fig. 6. The thread gage *D* is a piece clamped upon the dove-tail of the carriage as a stop for the thumb nut *d*, on the gage screw, *e*, which is fixed to the tool block *B*. By its use any one diameter may be turned with fairly accurate results. To obtain several diameters the pivoted gages *H*, *J*, *K*, are attached to it. These gages are made the exact thickness necessary to suit the variations in diameter of the finished shaft, and by folding one, two or three of them down between the nut *d*, and the thread gage clamp *D*, the tool *G* is stopped in the proper positions to correctly form the different diameters.

In the same manner the gage levers *m*, *n*, *p*, are pivoted to the clamp *Q*, fixed to the V's of the lathe, *R*, and by being brought down to a horizontal position will give the proper stops for the various lengths of the shaft from shoulder to shoulder.

The device is very simple in construction and use and by it the three shoulders and three diameters were turned without

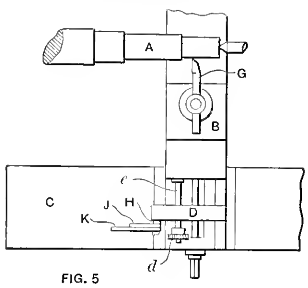


FIG. 5

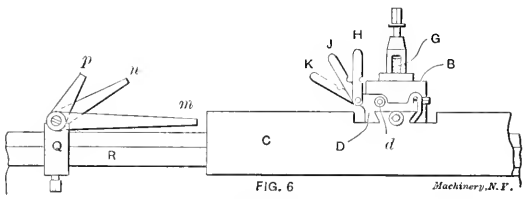


FIG. 6 *Machinery, N.Y.*

A Device for Turning Shouldered Shafts.

removing the shaft from the lathe. Four or five different dimensions could have been handled just as easily. The practical utility of the device is proven by the facts that the piecework price was 25 per cent lower than those produced by day work and yet the workman more than doubled his day pay. The machine capacity was therefore between two and a half and three times its former capacity, hence the machine rate per hundred pieces was very much reduced.

Another instance of reducing the cost by the addition of a mechanical device for that purpose is shown in the diagrams in Figs. 7 and 8. This was a case of cutting the teeth or "hobbing out" large bronze worm gears. It is well known that bronze is a very stubborn metal to cut, whether with a drill, planer, milling machine or gear cutter. In this case the wheels were about three feet in diameter and the pitch coarse, about four inch, and cut with a hob eight inches in diameter, hence great driving power was required. The original driving power of the hobbing machine is shown in Fig. 7, in which a gear *C*, of 96 teeth was fixed on the shaft carrying the "hob," engaging with a pinion *D*, of 24 teeth on the second shaft, upon which was a 20-inch pulley *E*, with a 4-inch face. The gearing ratio was, therefore, only four to one. The cutting was very slow and tedious as a very fine feed must be used owing to a lack of driving power. An improvement was determined upon. The pulley *E* was replaced by a gear *F*, of 120 teeth, engaging a pinion *G*, of 20 teeth which was mounted upon a new shaft upon which was also fixed the 20-inch pulley *E*, as shown in Fig. 8. This gave an additional ratio of 6, which, multiplied by the original ratio of 4 gave a driving power ratio of 24, instead of 4. It required nearly three weeks to "hob out" one of the worm gears as the machine was constructed (the

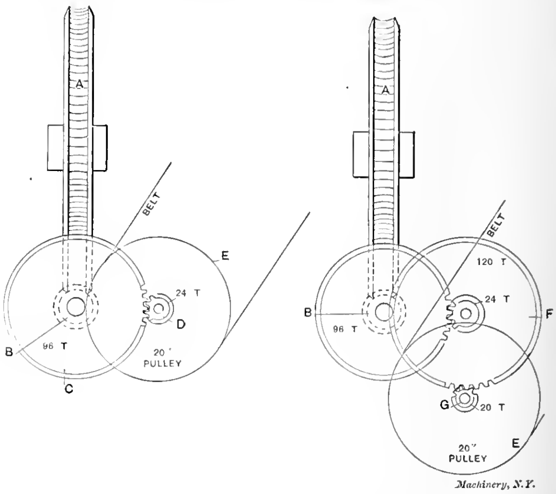


Fig. 7. Fig. 8.

A Change in Gearing to give Increased Power.

teeth were cut entirely from a solid blank) while with the improvement added the work could be done in four days, and the work was of a much higher grade, being much smoother and more accurate. Thus the cost was reduced to about 22 per cent of the original amount.

Many more similar examples might be given showing that it is often a simple matter to reduce the cost, and frequently to produce better work, by the addition of an economically constructed and easily operated device to the machine upon which the work is being done, and these will be vastly more appreciated by the management than the more elaborate and expensive, even if more scientific, devices sometimes seen in some of the shops that pride themselves on being strictly "up-to-date."

* * *

The development of machine tools, of course, naturally results in the improvement of one class of machines reacting upon the others. The features of design which have increased the output of a boring mill, for example, will to some degree apply in other machines, but designers are conservative in adopting such hints oftentimes. For instance, none of them, so far as we know, has apparently heeded the fact that the circular track, which is now considered practically indispensable for the boring mill table to support it rigidly under the thrust of heavy cuts, would be of almost equal value for lathes used for heavy faceplate work. It is obvious that the conditions are largely identical and it would seem that the boring mill construction would work for improvement in stiffness of the headstock support. Driving wheel lathes are common examples of tools which would be materially stiffened by such construction.

* * *

The Truesdale coal breaker of the Lackawanna Coal Co., at Scranton, Pa., is said to be the largest in existence, being 128 feet wide, 158 feet long, and 171 feet high. All the machinery is electrically operated and the slate is said to be mechanically separated. Its capacity is 6,000 tons per day.

THE SUCCESSFUL APPRENTICESHIP AND EDUCATIONAL SYSTEM OF THE GENERAL ELECTRIC CO., WEST LYNN, MASS.

The Thomson-Houston Electric Co., West Lynn, Mass.—a part of the General Electric Company—organized in 1902 an apprenticeship system under which boys are indentured as apprentices for a period of four years. The boys not only receive a regular shop apprenticeship course of instruction during this time, but also have a course of school training during working hours, amounting to two and one-half hours two days a week, forty weeks a year, for three years. Apprentices are paid by the hour, including time spent in the school room. Grammar school graduates receiving 6c. per hour for the first six months; high school graduates 8c. per hour for the same period, and thereafter all the branches are advanced 2c. per hour at the end of each six months.

The system of training at these works is one of the most successful and perhaps the most completely worked out of any in the country. It has been developed by Mr. M. W. Alexander, an engineer of the General Electric Co., and is under his immediate supervision. An address by Mr. Alexander recently published in the *National Civic Federation Review* fully describes the system and contains so many practical points of interest and so many suggestions for the instruction of mechanics that we reproduce it nearly in full.

In developing our apprenticeship system we recognized the necessity for educational development of the boys and incorporated into the system a school especially fitted for the needs of our apprentices. The lack of proper educational opportunities in the evening in the city of Lynn, such as, for instance, the city of Philadelphia offers in the Spring Garden Institute, was one reason which prompted our company to start its own school. The other reason was the desire to give to the boys eminently practical knowledge of the very kind which they will need later on as journeymen and foremen. We therefore selected our own engineers, draftsmen and shop foremen as teachers. These men know the needs of our factory and can impart to the boys the specific knowledge which they require in our own factory and, in a general way, in any manufacturing establishment of a similar character.

The school first met in the evening, when the factory closed; the boys assembled in the school rooms, partook of a light lunch furnished free of charge by the company and received instruction for about two hours. It soon became apparent that after a day's work the boys were too tired to reap the full benefit of the school instruction, and the evening school was therefore changed to a morning school. The blowing of the factory whistle in the morning is now the signal for the commencement of the school. The boys come to the school room physically and mentally rested. Formerly we had difficulty in keeping the apprentices in the school; now we rather experience difficulty in getting them out of the school room into the shop.

Theoretical Instruction.

Each boy receives three years of instruction. He enters school after he has been an apprentice for about six months and he graduates from the school several months before he graduates from his apprenticeship. Each school year consists of forty weeks with two sessions of two and one-half hours each week. The comparatively small amount of time devoted to instruction does not permit us to go very deeply into the various subjects which we teach. In fact, a large part of the teaching is merely a review of some of the grammar school work, but applied to practical factory conditions. Experience has prompted us to devote a good share of the time to this review and to carry it back to the elementary stage of the subjects which we desire to review. The rest of the time at our disposal is devoted to subjects which either have not been taught in the grammar school at all or have been touched upon only in a general way. An important aim in our review of grammar school subjects is to bestow upon the boy additional knowledge by giving him an insight into technology.

During the first year we teach English and mathematics, devoting one-third of the time to the former and two-thirds to the latter. In English, the spelling of technical terms is first taken up and then followed by short dictations explaining technical processes, describing materials and their properties and various kinds of apparatus. The boy, therefore, becomes acquainted in a general way with all our practical work.

Mathematics is the second subject which we review during the first year. We start with simple processes of addition, subtraction, multiplication and division, first of whole numbers and then of decimal and common fractions, finishing the year with proportion and percentage calculations. Alternating with arithmetic, we review mensuration.

Only concrete examples are given by the teachers, who as stated before, must aim to lead the boy on to independent thinking and to make him acquainted with the very technical arithmetic which he may have to use as a shop foreman. It is only a test of the boy's memory if you ask him to solve "$3 \times 420 \times 12$," but it is an entirely different test if you put the same problem in the following manner: "A factory consists of three rooms; each room is lighted with twelve arc lamps, each of which requires 420 watts of energy. How much horse power of energy will have to be provided for the lighting of the whole factory if 746 watts equal one horse power?" In stating such a problem, we explain in the very briefest manner the meaning of "watt" as a unit of measurement of energy, and we also explain briefly the nature of an arc lamp, showing the outside appearance of the same, and the inside mechanism. In fact, whenever a teacher speaks of a piece of apparatus or a part thereof, I insist upon having such apparatus or part shown to the boys, if this is at all possible. The boys will associate the picture with the name of the apparatus and will therefore retain the name better in their memory. I do not expect that the boy will learn fully the meaning of a watt of energy, or a volt of pressure, or an ampere of current, or for that matter, the operation of an arc lamp, the characteristics of an incandescent lamp, or the principles that govern the running of a motor. The terms "watt," "volt" and "ampere," "arc lamp," "incandescent lamp" and "motor" will become, however, familiar to him by frequent usage, and when, later on in the teaching of physics and magnetism and electricity, these same terms are brought before him again, they will appear to him as old acquaintances and will therefore make their study so much easier to him.

I desire to give one more illustration, taking this time mensuration as my subject. A problem may be commonly stated as follows: What is the weight of a steel rod one-half inch in diameter and fifty inches long? We state the problem in a different manner: "The machine shop is ordered to produce seventy-five steel pins, each to be one-half inch in diameter and three-quarters of an inch long. These pins are to be cut from a long steel rod and the tool for cutting off the pins will waste one-sixteenth of an inch of material between each two pins. How long a steel rod will be required, and what will be the weight of the same?" This is a problem which we meet in everyday factory life and which involves nothing else than plain multiplication and addition. It is simply a question of multiplying 75, the number of pins, by $\frac{3}{4}$ inch, the length of each pin, and adding to it 74 x 1-16 inch, which we have wasted by the cutting-off tool. The whole will give the length of steel rod required. Now this length is multiplied by the area of a half-inch circle to obtain the cubical contents, which, when multiplied by the specific gravity of steel (a figure which we give to the boy) will give the total weight.

During the first part of the second year, two-thirds of the time is devoted to square and cube roots applied to practical problems and to calculations of weights of different materials and machines. The remaining one-third is devoted to English.

We teach the boy to write "shop notes," by which I mean that we teach him to express himself in a very brief and clear manner and without flourish and frills. To illustrate: if a boy should be unable to finish a piece of work because his machine is worn out and, therefore, cannot be run at the proper speed, I expect him to notify the superintendent of this fact immediately—nothing else than what we would expect of any proper shop foreman. His note should, perhaps, be as follows:

I. F. Baker, Supt.:

I shall be unable to finish the 20 motor shafts by next Friday as promised, because my lathe is in very poor condition and cannot, therefore, be run at the proper speed. I expect to finish the shafts by Monday of next week.

(Signed) N. M. SMITH.

It is not necessary for the boy to start the letter with "Dear Sir." The superintendent knows how "dear" he is to the right boy without being reminded of it. It is a waste of time for the boy to write and for the superintendent to read a letter like the following:

I. F. Baker, Supt.:
I am extremely sorry to report that I shall not be able to fulfil the promise which I made you a few days ago in regard to the twenty motor shafts which I expected to finish by Friday of this week. The lathe on which I am turning these shafts is in very poor condition. I cannot, under the circumstances, turn out as fast work as I could if my machine could be run at a higher speed. I shall endeavor to finish these shafts by Monday of next week and hope that this delay will not cause you any inconvenience.
I remain, yours very truly,
(Signed) N. M. Smith.

Many a good shop foreman impairs his usefulness in a position of responsibility because he cannot write a correct and concise letter.

During the second part of the second year, English has been dropped entirely, and mathematics is only pursued on alternate mornings; the other mornings are taken up with physics with particular reference to mechanics.

During the third year, one morning per week is devoted to mechanical drafting, the other mornings to mechanics and mechanism, magnetism and electricity. Again we pursue the policy of speaking in concrete terms and illustrating these terms by the objects of which we speak. Our whole factory is utilized as a laboratory which not only aids in the proper understanding of the subject matter, but also arouses and keeps awake the interest of the boys. Mechanical drawing does not aim at the designing of machinery, but rather at the designing of the tools which journeymen need in the process of manufacturing machinery. We give, for instance, to the apprentice the cover of an arc lamp which has nine holes of different sizes and ask him to sketch a jig or holder by means of which these different holes can be drilled by a machine accurately and quickly without the necessity of laying out each hole separately.

The last few weeks of the third year are devoted to lectures on factory organization and factory systems. A boy too often acquires the idea, which sticks to him even after he has become a journeyman, that a foreman is after all nothing but a slave driver, whose chief duty is to obtain from the man the last ounce of work. We endeavor to show to the boy that the foreman is only one link, though an important one, in the big chain, which cannot operate if even the smallest link gives out. As soon as the boy begins to realize this, he begins to understand that even his own little efforts have their importance and are needed in the carrying on of the whole work; he will become a supporter rather than an antagonist of the foreman.

I attach quite an importance to these few lectures and to the effect they should have upon the future working men. An ambitious working man may inquire the reason for doing a certain thing in a certain way. What is the usual answer that most foremen will give him? They will tell him in a more or less polite way that it is none of his business; that he should bother about his own work and not waste time by asking such questions. I believe most decidedly that it is an ambitious man's business to understand, in a general way, the conditions that surround him and the reasons for carrying on work in the way in which he is directed to perform it. A question asked in the right spirit deserves some answer in the same spirit. The man will be benefited by it and the company will be better off for that.

I think it of sufficient interest to state here a psychological element in our school work. If we ask a boy to figure out the weight of a piece of brass three inches long by one inch in diameter and tell him that he is wrong if his calculation does not give the proper figure, he may assume an attitude of antagonism to the teacher. We give to the boy a piece of brass, let him measure the same and sketch it on a piece of paper and calculate the weight. We then hand to the boy a pair of scales to check his own results. If now the scales tell him that he is wrong, he will feel rather ashamed of himself and re-calculate the problem with the earnest desire of arriving at the proper figure. The boy has, so to speak, a greater confidence in the veracity of the scales than in the veracity of the teacher.

An examination is held at the end of each term, and only those apprentices who obtain a percentage of 60 or more are allowed to advance to the next school term. Some have been left behind. The knowledge of their failure, however, became quickly known among their shop-mates and had a most stimulating effect on the mental machinery of these boys. The final examination after three years of schooling is a competitive one, wherein everyone who obtains a percentage of 95 or more is presented by the company with a technical book or a useful working tool. The standing obtained in the school is also stated in the "certificate of apprenticeship," which is given to the boy at the successful termination of his apprenticeship, together with a cash bonus of $100.

Practical Training.

At the same time with the theoretical instruction in the school, practical instruction in the handling of tools was carried on in the shop. We soon recognized, however, that there must be a very close connection between the theoretical and the practical instruction, so that a boy may be stimulated to apply every day to the work-shop what the school has taught him. The difficulty can easily be understood of giving systematic practical instruction in the factory with an equal chance of giving the same training to all boys and yet of taking into account the individuality of every apprentice—the quickness of his mental grasp, the dexterity of his hand.

The work which apprentices perform in the different shop departments must of necessity be governed to a large extent by production requirements. One department may be very busy to-day and may offer splendid opportunities for the boys, while to-morrow, it may have to work up only a small amount of production of a character, perhaps, which does not give the apprentices a really good chance. Then, again, the practical instruction in the shop is influenced materially by the individuality of the workmen, assistant foremen and foremen, all of whom act as instructors to the boys.

In order to equalize and improve the conditions it was decided a year and a half ago to concentrate the first practical instruction in a separate department, the apprentice training room, and to make the factory a post-graduate course, for the purpose of acquiring increased speed and accuracy on a greater variety of work. The factory would then not only apply the finishing touches to the boy's practical education, but would bring him face to face with real factory conditions and the emergencies that arise. The apprentice training room is, therefore, a second part of the apprentice school and may justly be called a trade school in contradistinction to the theoretical school which we have just described. The training room is in charge of a man who is not only an expert mechanician with inventive ability, but one who takes an interest in boys and understands how to handle them. This man, therefore, has the responsibility of not only initiating the boys into the trade in such a manner as to lay a solid foundation for their future work, but also of arousing in them the proper interest in and respect for manual labor. He furthermore has the opportunity of studying closely the boy's make-up, so that he may drop from the apprentice course those who do not display the qualities which are essential for a successful career, and he has a chance to develop an inventive capacity in those who by nature are endowed with inventive minds.

Every apprentice has first to enter the training room, where he will be kept from nine to twelve months, according to his ability. Bench-work during the first month is followed by work on simple machines, such as drill presses, from which the boy advances to work of a more difficult character on different lathes, on planers and shapers, on boring mills and milling machines. Some old machines have been rescued from the scrap heap and placed in the Trade School, in order to afford the boys a chance to make repairs—an excellent training for a machinist and an opportunity to develop the ability to meet emergencies. They are also taught to take care, for a short time, of the stock room, which is a part of the training room, and to perform such clerical work as making out time-cards and order blanks, which is required of every assistant fore-

man and foreman. During the last few months of their stay in the trade school, the best boys act as assistants to the man in charge, looking after some of the new apprentices.

The present equipment of our training room is limited, due to lack of sufficient room, so that we can take care in it of only about forty apprentices at a time, while about 150 apprentices are distributed through the shop. As those at the top are graduated into the factory post graduate course, new freshmen, or, rather, fresh young men are taken in. We expect to move into a large, well-equipped building in the near future, when we shall be able to accommodate a larger number of apprentices.

The object of our whole apprenticeship system, as I have already pointed out, is to develop a very high class of employes. Their technical education should therefore be of as broad a character as possible, because with this better education goes a greater sense of responsibility, a firmer grasp of the work, a better understanding of the business methods. This aim cannot fully be accomplished within the compass of our theoretical school. I have therefore supplemented this school by an apprentice club, where the apprentices may congregate in their leisure hours for social as well as educational enjoyment. Expert engineers lecture to the boys once a week on various subjects which are allied to their business and stand ready to enlighten the boys further by answering any questions which may be asked during discussion. The club has been handsomely furnished by the company, but is conducted by the boys themselves, with a representative of the company on the board of directors. It is very interesting to observe how well the boys conduct the business of their club, which develops in them a business instinct and self-reliance.

These three institutions, therefore, namely, the theoretical school, the trade school, and the apprentice club, constitute the apprentice school of the Thomson-Houston (General Electric) Company at West Lynn, of which you did me the honor to invite me to speak to you to-night.

There have been certain changes in the apprenticeship school of the General Electric Co. since the address, of which the foregoing is an abstract, was delivered. Mr. Alexander writes that a new course of studies has been adopted and that the school is held from 3 to 6 P. M., instead of in the morning, with two sessions per week for each pupil. The standard of the whole apprenticeship system has been raised and on account of the greater discrimination made among those who are accepted for apprenticeship an increased wage schedule has been decided upon and carried into effect, as follows:

For the trial period.............	8 cents per hour
For the first six months.........	8 " " "
For the second six months........	10 " " "
For the second year	12 " " "
For the third year	14 " " "
For the fourth year..............	16.5 " " "

with the same bonus of $100 cash.

It is interesting to note that an increasing number of high-school graduates are taking the apprenticeship course at the works.—Editor.

* * *

One of the interesting developments of automobile construction is the extensive use of ball bearings in the transmission machinery. While ball bearings are by no means a new thing, their limitations have generally been supposed to prevent their use where reciprocating action involving heavy stresses was necessary. The success of ball bearings applied to the crankshafts of automobile engines suggests the idea that it may be feasible to do away with the expensive crankshaft as now made and substitute a shaft having instead of cranks, cams or eccentrics equal in throw to the stroke of the piston. The connecting-rods would then be in appearance similar to eccentric straps, fitted with ball bearings. The use of eccentrics with plain bearings is, of course, out of the question because of the large proportion of the power wasted in friction, and the consequent heating, but with ball bearings the friction loss is comparatively small, and, provided ball bearings can be made to stand the peripheral speed necessary with eccentrics running at 600 or 800 revolutions per minute, it may be that this construction offers a way of escaping the manufacture of one of the most expensive parts of the four-cylinder engine, that is, the four-throw crankshaft.

REPRESENTATIVE AMERICAN MECHANICS.

CHRISTOPHER M. SPENCER

Christopher Miner Spencer was born at South Manchester, Conn., June 20, 1833. At the age of 12 he went to live with his grandfather, a Revolutionary soldier, and while living there he first evinced his taste for firearms and native mechanical ability by sawing off the end of his grandfather's musket so that he could use it for squirrel shooting. To do it he used an old table knife which he had converted into a hack-saw, notching teeth on the back by striking it on the edge of an old ax. In 1847, at the age of 14, he went to work for Cheney Bros., silk manufacturers at South Manchester. Leaving there, temporarily, he went with Samuel Loomis at Manchester to serve eight months apprenticeship at the machinists' trade. He went to school the following winter, and again served another eight months' apprenticeship the following year. He then returned to Cheney Bros., and under the direction of Frank Cheney, began experimental work as a journeyman. Here he took out his first patent for a spooler. Desiring to obtain a wider mechanical experience than was possible in his native town, he left in 1853 and went to Rochester, N. Y., where he worked for about a year repairing locomotives. Further experience, this time on firearms, was gotten in the Ames works at Chicopee, Mass. Upon returning to Hartford he secured employment in Colt's Armory, and there conceived the invention of the Spencer repeating rifle, the first of the type to use metallic case ammunition. The metallic cartridge was the invention of C. D. Leet, of Springfield, Mass., and had heretofore been used only in single-shot rifles and revolvers. The first Spencer seven-shot rifle having the magazine in the stock was brought out in 1860. Cheney Bros. took up its manufacture, and gave Mr. Spencer a bonus of $5,000 and a royalty of $1 a gun. These rifles were largely used during the Civil War, something like 200,000 being made and sold to the government. During the war Mr. Spencer presented one of his rifles to Abraham Lincoln at the White House, and then he and Lincoln shot a score on the grounds near where the Washington Monument now stands. The target consisted of a pine board having a bullseye at each end, Lincoln shooting at one bullseye and Spencer at the other. This target is preserved in the museum at Springfield, Ill., along with other Lincoln relics. Mr. Spencer tells some interesting anecdotes concerning "Honest Abe" and considers that he was one of the most wonderful men he ever met. As an illustration of the unconventional manner in which government business was conducted at that time, Mr. Spencer says that when they were examining the rifle, Lincoln sent his eldest son, Robert, over to the War Department to call on Secretary Stanton to see the gun, but Stanton sent back word that he was "too busy." Lincoln sighed, and said, "You see they do pretty near as they please around here"; but as a matter of fact, no one could be firmer than he when necessary.

The manufacture of the gun had been transferred to the Spencer Repeating Arms Co., in Boston, Mass., but at the close of the war the demand ceased, and the company sold out to the Winchester Arms Co., New Haven, Conn. From there Mr. Spencer went to Amherst, Mass., and in company with Henry F. Hills organized the Roper Repeating Arms Co., to manufacture the Roper shot-gun. This venture was unsuccessful, and Mr. Spencer bought it out and removed it to Hartford. But in its manufacture he had gained valuable experience in the making of drop-forging, and in 1869, in company with C. E. Billings, he formed the Billings & Spencer Co., to manufacture drop-forgings.

A few years later he made the invention which marks an epoch in the machine tool business, and that is the Spencer automatic screw machine. The first machine was set to work in 1874, being a Pratt & Whitney turret lathe, to which was fitted the cam drums for making its operations automatic. This machine was fitted up on the second floor of the shop of the Cushman Chuck Co., which stands on Cushman Street. The Hartford Machine Screw Co. was organized in 1876 and the machines were built by the Pratt & Whitney Co. This business Mr. Spencer sold out in 1882 to again enter the manufacture of firearms. A company was formed which began in 1883 the manufacture of the "trombone" Spencer repeating shot-gun, at Windsor, being capitalized at $400,000.

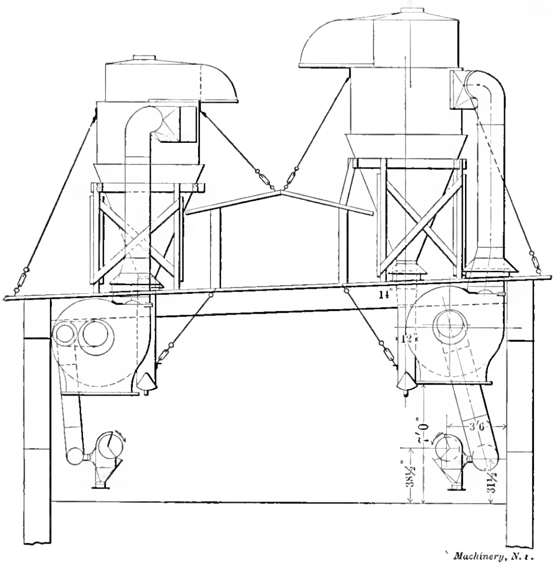


Fig. 2. Sectional Elevation of Dust Collecting System.

In 1883 Mr. Spencer, in company with a party, took the gun to Germany to introduce it, and while there met a number of famous German officers, who were well acquainted with the Spencer repeating rifle. Some of them asked him if he was a relative of the inventor of the repeating rifle, and when he informed them that he was the inventor, they were astonished beyond measure, and it was with difficulty that they were convinced. This venture was continued until 1888, when it was sold to Francis Bannerman, Brooklyn, N. Y., who continued the work there; Mr. Spencer withdrew, a poorer man for his experience.

Notwithstanding his brilliant genius and the inventions which he made, especially the automatic screw machine, he is to-day in very moderate circumstances. The thousands, or rather millions, of dollars which have been added to the world's productive capacity as a result of the automatic screw machine have gone to other people, as is generally the case with epoch-making inventions. Mr. Spencer is still active, and since 1888 has been devoting his time to the improvement of automobiles and automatic screw machines. He is now superintendent of the Universal Machine Screw Co., a concern recently organized in Hartford to manufacture an improved multiple-spindle machine of his design, having five working spindles.

EXHAUSTING ARRANGEMENT FOR GRINDING AND POLISHING WHEELS.

In the plant of the Victor Talking Machine Co., Camden, N. J., are installed, in a single room, twenty-two buffing wheels and eighteen grinding wheels. These are arranged in two groups, each equipped with a complete exhausting system connected to its individual fan and dust collector. The general construction of the hoods, arrangement of piping, and location of fan is indicated in Fig. 1, showing one side of the room. The hood in each case nearly encases the wheel but leaves ample space in front for the workman. Adjustable flaps at

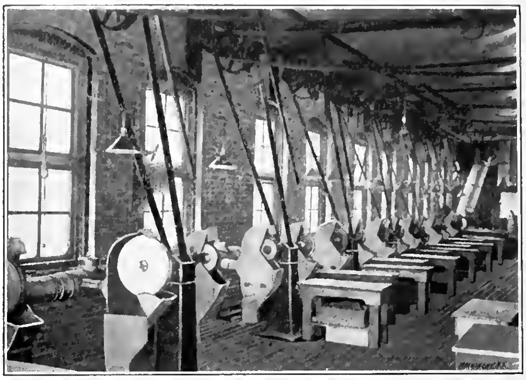


Fig. 1. Polishing Room of the Victor Talking Machine Co.

the top and bottom assist to prevent the throwing of dust and coarser particles into the room. The outer side of each hood is hinged so as to drop down out of the way and allow of the ready removal of the wheel. This arrangement is clearly shown in the case of the hood nearest the observer, as is also the method of connection of the exhaust pipe to the hood.

The design of the hood is such that all but the very finest material is thrown or falls to the hopper at the bottom, whence it may be periodically removed. The finer particles are drawn through the connecting pipe in the rear which expands as it approaches the hood so as to equalize the current of air and reduce the velocity of entry. As a natural result the fan draws away only the minute particles, thereby reducing the

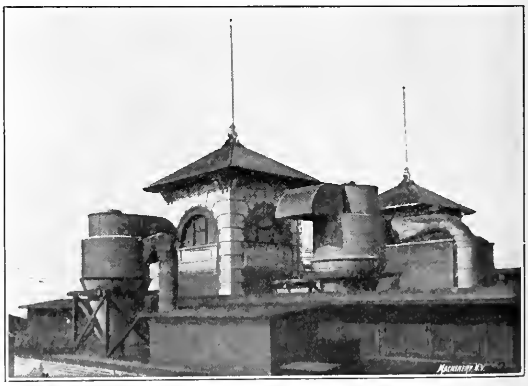


Fig. 3. Dust Collectors on the Roof.

chance of clogging and decreasing the work which the dust separators have to do. All hood connections enter horizontally a pipe which runs immediately behind the hoods and against the wall. Cleanouts placed at intervals along the top of this pipe make it possible to keep it perfectly clear.

From the fans the dust-laden air is discharged up through the roof into dust collectors, Fig. 2, each of which is provided with a special hood. The absence of dust in close proximity to the finely finished towers of the building is very clearly indicated by the photograph. The entire system was installed by C. H. Gifford & Co., managers of the Philadelphia house of the B. F. Sturtevant Co.

ARRANGING A BROWN & SHARPE CUTTER GRINDER FOR GRINDING SNAP GAGES.

A. C. LINDHOLM.

The cut, Fig. 1, illustrates a No. 3 B. & S. cutter grinder with a micrometer attachment placed at the right of the machine. This device consists of a casting *H*, which is clamped to the main guide-bar *M*. Another casting *F* is fastened with screws to the bearing *N* of the guide-bar. This part of the device has a tapped hole, 40 pitch, for the screw *L*; *K* is the graduated knurled head of the screw. The cut fully illustrates the device in position, also the plate *D*, which is fitted to the head *E*. This plate holds the work on gage *G* to be ground. *A* is the spindle and *B* the emery wheel of the grinder. Before adopting this device great care had to be taken to grind a gage correctly, the only arrangement being a clamp or stop on each end of the guide-bar having a knurled head screw with a coarse pitch.

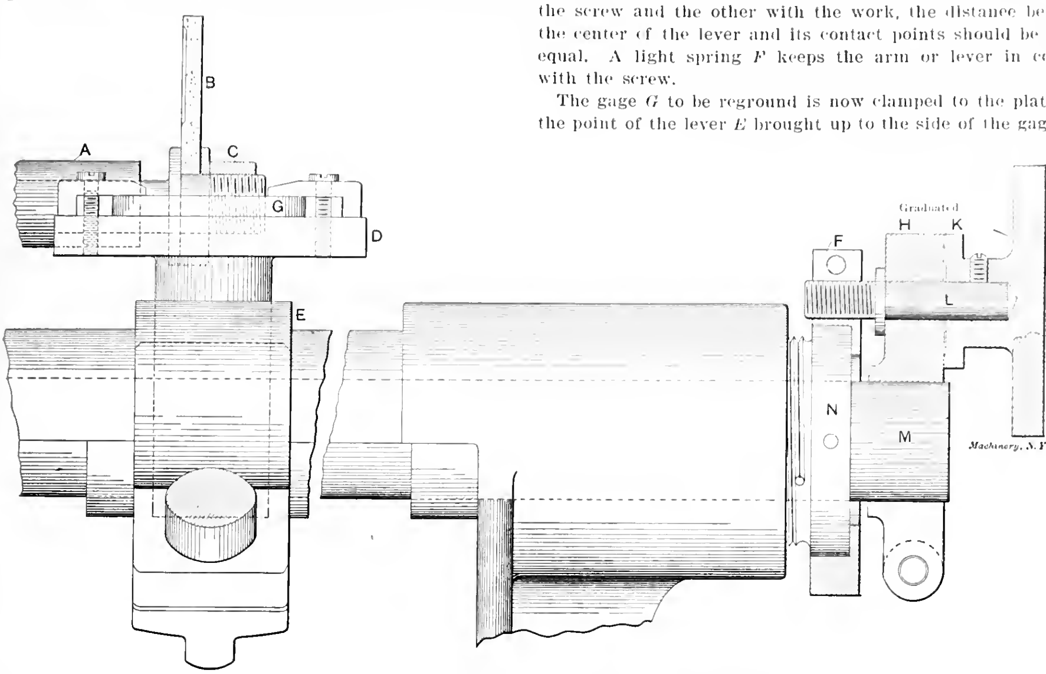


Fig. 1. Brown & Sharpe Cutter Grinder arranged to Grind Snap Gages.

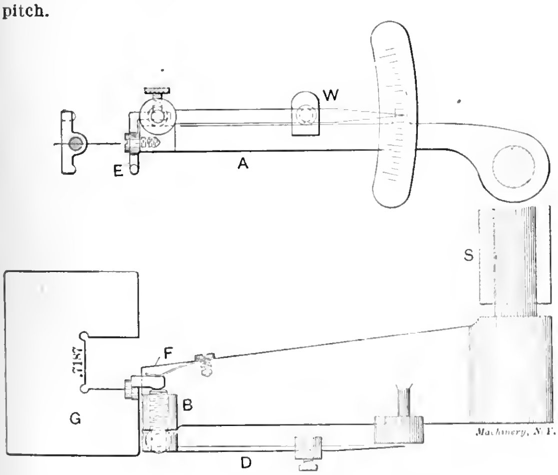


Fig. 2. A Micrometer Gage for Resetting the Work.

Often the dimensions of certain pieces of work are changed, allowing more limit to diameter or size as the case may be, increasing the limit one or two thousandths of an inch or more. This necessitates a new gage, or grinding the old one to the new size. When but a thousandth or two is to be taken out, great care must be taken in setting up the job correctly. The gage or indicator, Fig. 2, was designed for indicating a correct setting of the work. The casting *A* is of gray iron, into which is fitted an arbor which also fits the wheel spindle *S* of the grinder.

A 40-pitch thread is tapped in the projection *B* and a screw is fitted to same. At the end of the screw a pointer *D* is fastened for indicating the truth of the work. A small lever *E* is screwed fast to the casting, one end being in contact with the screw and the other with the work, the distance between the center of the lever and its contact points should be about equal. A light spring *F* keeps the arm or lever in contact with the screw.

The gage *G* to be reground is now clamped to the plate and the point of the lever *E* brought up to the side of the gage and the reading on the graduated arc is noted. The pointer is then raised and the head or gage is moved out to the end of the work so as to get the reading at both the inner and outer points. The pointer is lowered and the difference in the reading, if any, is noted. The weight *W* can be placed so as to give the desired tension. The graduation is in thousandths inch. The pointer must not be dropped suddenly but gradually, thereby giving a correct reading. During the setting the indicator is held rigidly in the wheel spindle, the latter being prevented from turning by setting up the take-up collar. In this manner the setting of the gage face parallel with the slide is assured.

* * *

Mr. C. W. Naylor, at the fall meeting of the A. S. M. E., related a peculiar experience with the bearings of a jack shaft in the engine room of a Chicago establishment. The shaft was of steel 5 inches in diameter and 18 feet long, running at 250 revolutions per minute, receiving and transmitting 175 indicated horse power from a pair of steam engines and driving by leather belts five electric generators. The pull of these belts, as well as that of the engine belt, was all in the same direction. The bearing boxes were 14 inches long, non-self-oiling and split horizontally, made of case iron and babbitt filled. For the first two years much trouble was experienced in keeping the boxes cooled with oil, of which several grades were tried, as well as various brands of grease. In 1890 Lake Michigan hydrant water was tried as a lubricant with such good results that it was continued until 1901, a period of eleven years, without any serious interruption, for ten hours each week day. A small stream of water was allowed to trickle through the bearings, and for five minutes before closing down oil was fed into the box to prevent the shaft from rusting and sticking over night when the machinery was not in use. The wear on the babbitt and box for the eleven years was about 1/4 inch; on the shaft it was nil. The increase of temperature in shaft and box was inappreciable and less trouble was experienced with eleven years' use of water than with one month's use of oil. The plant was abandoned in 1901.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1906.

PAID CIRCULATION FOR MARCH, 1906,—21,799 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

LOW-SPEED TOOLS AND HIGH-SPEED STEEL.

The following inquiries come to us from Germany in regard to high-speed steels: "I should like to hear the opinions of your readers as to the value of the new high-speed steels (1) when used on the old-fashioned machine tools not designed for the high cutting speeds possible with new tools; (2) for milling cutters and similar tools."

Definite information upon both of these subjects is badly needed, but the first part of the inquiry is after all the most important question that the shop superintendent has to deal with in introducing high-speed steels. Only those who can afford to throw out the old and put in the new are in a position to take full advantage of the increased output that is to be had from high-speed cutting tools. In the average shop this change of equipment must be in the nature of a gradual development extending over a period of several years. As one superintendent has expressed it, who presides over a shop that has not as good an equipment as he would like, "Traveling cranes, electrically-driven tools and high-speed steel have come upon us almost at the same time. What are we to do?"

There is some consolation, however, for those who have to get along with these conditions as best they can. The chief function of a machine tool is not in the majority of cases to remove the greatest possible weight of metal in a given length of time. In a manufacturing shop it is cheaper to have castings and forgings come somewhere near the finished size than to depend upon the lathe and planer to do it all and it is not economy to attempt to take a heavier cut than the stiffness and strength of the work itself will warrant, however heavy and modern the machine may be in which the work is placed. Furthermore, if the facts were known the foreman in any department of a shop would be surprised to find how small a percentage of the time was required for the actual cutting and how large a percentage for setting up and changing the work. We know of one case where a recording ammeter was attached to a planer and the line traced by the instrument showed the planer to have been on the waiting list 50 per cent of the time. Even in the Taylor system of rate setting, by which such remarkable results have been achieved, the gain does not all come from the high cutting speeds set for the work. A greater or less proportion of the saving, depending upon the character of the work itself, is due to the specific directions given for the order of operations and the precise manner in which they are to be performed.

The foregoing comments are made, not to advocate the use of old-fashioned machine tools in place of the modern, heavy tools, but to suggest that where it is not possible to get the new machines as rapidly as desired there are still opportunities for a substantial saving in time and money, not alone by speeding the old machines up as much as they will stand, but by giving attention to the other features that contribute towards the cost of machine shop work.

* * *

DENATURIZED ALCOHOL.

The prospects of a bill being passed by the present Congress for removing the tax from denaturized alcohol are not particularly encouraging, but educational work is going on which will eventually cause this desirable legislature to be enacted. Expert witnesses have been called before the House Committee on Ways and Means who have told of the great possibilities of cheap alcohol in the arts and industries and what it will mean to the agricultural interests of the country. In many parts of the country denaturized alcohol would be cheaper fuel than coal and as an illuminating fluid with the proper form of burner it would be cheaper and more satisfactory than kerosene. Naturally, therefore, every vested interest affected is working tooth and nail to defeat any such radical change as would be brought about by the abolishing of the tax, which is now $1.10 per "proof" gallon. The "proof" gallon is the basis for the tax and is a wine gallon (231 cubic inches) containing 50 per cent pure alcohol; if the alcohol is 90 per cent. pure, for example, the tax is $1.98 per gallon.

To show the beneficial effects of free alcohol on general industries, it is pointed out that the manufacture of artificial silk in Europe is made possible by its use, but in this country it is out of the question, for cotton cloth, treated with taxed alcohol in the manner prescribed for its manufacture, costs nearly or fully as much as the real silk article. The growing demand for gasoline for use in the internal combustion engines used on automobiles, motor boats and for general power purposes is steadily increasing the price of this article, which at best is of a very limited output, and there is little prospect of the supply of gasoline being materially increased. Most of the new oil territory that is being developed produces petroleum in which the lighter oils like benzine and gasoline are present in very small degree. Alcohol free from tax would mean that vast quantities of farm products which are now largely waste material, could be made into a product of universal use, for alcohol can be made from anything containing starch or sugar. Potatoes, turnips, corn stalks, beets, wood, sawdust, straw, or anything of this nature can be made to produce a certain measure of alcohol in apparatus of very simple and easily operated nature. It is claimed that from the corn stalks grown in the West many millions of gallons of alcohol could be made, it being estimated that from this source alone the value of the annual corn crop could be increased fully $25,000,000.

* * *

The adoption of an appropriate name for any manufacturing business is very important, for it oftentimes has a deciding effect in the success of the concern. If possible the name should tell the business and also the place. It is obvious that the name "Smith Bell Co." tells more than "Smith Manufacturing Co.," but "Schenectady Bell Co.," for example, is still better. It not only discloses the business but also the location of the concern so far as the name of the town is concerned, and this is usually enough. Such a name in the directory is self-explanatory but what is more important is that possible customers will more readily remember a concern so named. Advertisements in trade journals do not yield all their results immediately; it is no uncommon thing for firms to get answers to "ads" that appeared ten or twenty years before. Many more returns would be received if people could always remember "who" and "where." On the other hand, a firm name may tell too much. To illustrate, suppose for example the name of the concern is "Perkins Plow and Watch Co." It is conceivable, of course, that a concern could build both good plows and watches, but the combination is certainly in poor taste, both from a manufacturing standpoint and in the trade name. If a concern is engaged in dissimilar enterprises like this a blanket name that tells nothing would seem better than one that tells all.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Regarding the value of the exponent n in the expression PV^n = constant Mr. C. P. Poole of *Power* in a letter to the *Horseless Age* of January 24 says its value may safely be taken as 1.3 for the compression curve and 1.35 for the expansion curve of a gas engine indicator diagram. This would indicate that the usual value of 1.41 given in the older text books is quite wide of the mark.

A correspondent of the *Engineer* describes a heating coil connection to an exhaust steam line, which introduces no back pressure. The radiator or heating coil supply is connected into the upper side of the exhaust pipe and the return or drip connection to the lower side of the exhaust, so that condensation will accumulate and form a water seal. This seal permits the condensation to overflow into the exhaust line gradually as it accumulates. It is plain that the combination acts as a vacuum system, the reduction in pressure being measured by the effective head of water in the discharge pipe. There should be an air cock on the heating coils at the drop connection for removal of air.

Some of the most interesting experiments in chemistry are made with simple apparatus and much of the work of the experimental laboratory is done with tools and appliances of a primitive nature. The *Mining Reporter* tells how small quantities of gold may be freed of mercury, which may be cited as a case in point. "To procure the gold from small quantities of amalgam, a potato retort may be made. Cut a medium sized potato in half and hollow out one piece. Now make a depression in an old shovel or piece of sheet iron and place the amalgam therein. Cover with the potato, taking care to make it fit snugly. Heat very slowly until the potato bakes fast to the iron and thus seals the retort. Then raise the heat and maintain it at redness for a few minutes. Upon subsequently removing the potato, the gold will be found free from mercury, and it can be further purified by boiling in nitric acid."

In an article on workmanship in riveting by Mr. A. J. Himes in the *Engineering News* a number of tests are given by which a loose rivet in a structural fabric may be detected. If loose the impact of a hammer on the head will produce a dull click or the looseness may be detected by sight, as a very slight motion will be observed. If the rivet head is in such a position that water can stand around it the very slightest vibration will be detected in the motion of the water. A tight rivet will cause the hammer to rebound freely, but if loose there is little recovery after impact. Again a finger laid against a rivet while struck with a hammer blow on the opposite end will detect any slight vibration due to looseness. The best way to detect looseness is to take a thin metal washer between the thumb and fore finger and hold it against the rivet head while the blow is struck by a small hammer on the opposite end. The slightest looseness can be readily detected in this manner.

The relative torsional strength of steel and wrought-iron pipes was tested by the National Tube Co. and reported in a paper read before the American Society of Heating and Ventilating Engineers. The pipes, in lengths of 6 feet each, were tested in an engine lathe. One end of the pipe to be tested was caught in a four-jaw chuck and the other end was supported on the tailstock center and also by the steadyrest. A lever was clamped to the tailstock end of the pipe, the outer end of which was supported by a spring balance at a radius of 3 feet. Tested in this manner a ½-inch steel pipe gave a maximum pull of 190 pounds and twisted fifteen turns before breaking, the weld remaining intact. The results with ½-inch iron pipe were much lower. With one lot the average pull at the end of the 3-foot lever was only 65 pounds and all the samples failed in the weld with 2½ turns. The best result was an average of 81 pounds pull, 5¾ turns, and the failure of 66 per cent in the weld. The next size, ¾-inch steel pipe, gave a maximum average pull of 172 pounds, and 8 turns before failure, of which only 13 per cent failed in the weld. Iron pipe of the same dimension gave in the best average test 154 pounds pull, 6.2 turns and 33 per cent failure in the weld. With 1-inch steel pipe, the average pull was 300 pounds, 5½ turns and 13 per cent failure in the weld. Iron pipe of the same size gave an average pull, in the best test, of 256 pounds, 4½ turns and 46 per cent failure in the weld; the poorest showing, as regards the integrity of the weld, was 258 pounds pull, 2¾ turns and 66 per cent failure in the weld.

In the December issue of MACHINERY (Engineering edition) mention was made of a device for testing the flow of artesian wells by means of a red aniline fluid injected into a horizontal section of pipe having a known diameter and length. The time required for the red fluid to show at the end of pipe gives the data necessary for calculating the flow of the well. A correspondent of the *Valve World* describes a variation of this method which has been used by well drillers and which does not require any additional pipe above ground. The plan is to lower a bottle of aniline fluid containing a dynamite cap connected by wire to a battery at the surface. When the bottle has been lowered to a depth of, say, 500 feet the cap is exploded and the bottle bursts. The lapse of time between the firing of the cap and the appearance of the colored water at the surface gives the data necessary for calculating the flow. It is claimed that the flow may be obtained in this manner as accurately as if measured by a weir.

The success of Niagara power development and the great returns realized on the original investment have naturally called attention to undeveloped water powers throughout the country. The possibility of electrically transmitting power 100 or 150 miles or more has made many water powers valuable which a few years ago were so remotely situated as to be of little or no value except for small local enterprises. In an article by Mr. Alton D. Adams in the *Electrical Review*, the possible power development of the Adirondack region is reviewed. It is stated that Adirondack water develops 200,000 continuous horse power in its descent to the sea level. On the basis of 300 ten-hour working days per year it means that this water would develop more than 500,000 horse power, provided of course that suitable storage reservoirs were made to hold the water during idle periods. In conclusion the author says, "Silence every steam engine in the State of New York, and Adirondack water will carry their loads, if storage is provided to conserve it; and electricity distributes its power."

The reduction of buildings to marketable materials instead of junk has reached the dignity of an important engineering profession in modern housewrecking. The tearing down of a collection of large buildings like those at the Pan-American or the Louisiana Purchase exposition so as to get marketable products with the minimum of waste requires much care and good judgment. In an article upon the subject in the January issues of *Cassier's Magazine*, Mr. Geo. E. Walsh reviews the growth of this industry. The steel skeletons of modern buildings are most valuable. They are taken down very carefully and the average housewrecker can dismember such a building so that the loss is restricted almost entirely to the rivets. This old material is used in new structures, the structures often being designed so as to fit the available material. Where it is known that structures such as those for expositions are to be demolished after their close it is part of the business of the wrecking companies to keep careful account of all the material entering the structure so as to be able to estimate intelligently upon its value after its demolition.

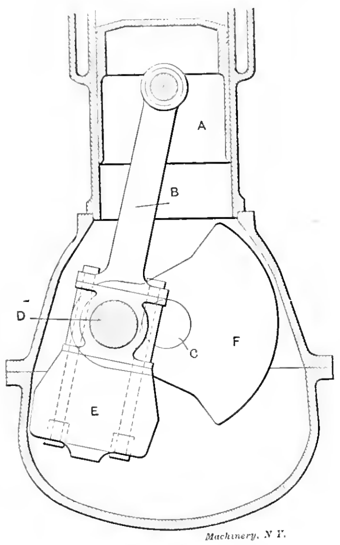
Hydrofluoric acid as a cleaning agent for castings has not been in general use for any great length of time, and a few years ago was treated as a secret process by those who understood its value and made use of it in removing sand from castings, says a writer in the *Foundry*. Several formulas have been

sold for this pickle for considerable sums, said formula having several superfluous ingredients in them to mystify the unsuspecting buyer. But the fact is, anything used in connection with this pickle besides hydrofluoric acid and water is entirely unnecessary. The usual formula for removing sand from brass castings is hydrofluoric acid 1 part and water 10 parts. It must be remembered, however, that this acid comes in different degrees of purity; if the weaker acid is used, less water is added to the drip; if the stronger grades are used, more water should be added, but there is no set rule as to the amount of acid to be used. The idea is to get a dip that will remove the sand quickly and perfectly from the casting; this operation usually requires from 10 to 15 minutes depending entirely upon the amount of sand to be removed and the condition of the pickle; of course, a newly-made pickle works much faster and cleaner than one that has been in use for some time.

METHOD OF BALANCING GAS ENGINES.

Mechanical Engineer, February 24, 1906.

A patent has recently been granted to Armstrong, Whitworth & Co., Ltd., and W. G. Wilson, of Elswick Works, Newcastle-on-Tyne, for a method of balancing steam and other engines, more particularly explosion engines. For the purpose of balancing the moving parts a weight is attached to the connecting rod on the other side of the crank pin to the cylinder. This weight and its distance from the crank pin is such that the center of gravity of the piston, the connecting rod, and weight is at the crank pin. In the case of single-cylinder engines, a weight is also attached to the crank, on the opposite side of the crank shaft to the crank pin. This weight, and its distance from the crank shaft, is such that the center of gravity of it, the other weight, the connecting-rod, and the piston is at the crank shaft. In engines having two or more cylinders, the dimensions of the second weight may be varied according to the degree to which the several cranks balance each other.



The accompanying illustration shows a section of an engine fitted with the balancing arrangement. A is the piston, B the connecting rod, C the crank shaft, and D the crank pin. E is a weight attached to the connecting rod, such that the center of gravity of the piston A, the connecting rod B, and the weight E is as near as may be at the center of the crank pin. F is a weight attached to the crank, such that the center of gravity of the piston A, the connecting rod B, and weights E and F is as near as may be at the center of the crank shaft.

AN ICE AUTOMOBILE.

Scientific American, February 24, 1906, p. 174.

The development of the steamship, the locomotive and the automobile, and the still later conception of the dirigible airship, would seem to have exhausted the field of novel means of transportation. Yet a machine which is in its basic principle a decided innovation, has been designed and constructed by a Minneapolis man, Charles E. S. Burch, who has experimented for years in practical demonstration of his idea. The machine in question is now resting on the ice of Lake Calhoun, where it has been tested, for, it must be understood, the machine is intended to travel on a frozen surface. The object which the inventor has had in view is the revolutionizing of the means of winter transportation in Alaska, where he is heavily interested in mining properties difficult to develop because of their inaccessibility. At present, in certain parts of Alaska, freight transportation during the winter is accomplished entirely by dog-teams and sleds, and in consequence the charges are from \$100 to \$1,000 a ton. It is the inventor's plan to use in place of dog-teams his "ice locomotive" drawing a train of sleds, and in this way to reduce the expense of freighting to a minimum. It is hoped that the invention will prove a boon to winter commerce in Alaska, and should it succeed will doubtless be received with enthusiasm by the thousands in that frozen country, who in winter are practically shut out from the civilized world.

The ice locomotive is propelled by steam engines, but instead of resting on wheels or runners is supported by four great steel spirals, one at each corner of the body, in the places usually occupied by the wheels or runners of ordinary vehicles. The spirals lie with their axes horizontal, and are of right- and left-hand pitch for the opposite sides. The edges of the blades are fashioned like skate blades in order that they may grip the ice well. Each of the spirals is directly connected to a separate steam engine and consequently the spirals may be operated independently, this method giving unusual control over the car. It can be driven forward, backward, sideways or at any oblique angle desired, and it can even be made to spin around like a top. The model now at Lake Calhoun is 22 feet long, weighs 4½ tons, has engines of 42 horse-power and steel screws 27 inches in diameter. It is easily seen that the greater the diameter of the spirals the greater will be the ability of the ice locomotive to travel over rough surfaces and to surmount obstacles. Accordingly, a machine which the inventor is having built in Canada, to protect patent rights in that country, will have spirals six feet in height. The ice locomotive is steered by means of two semi-circular steel disks at each end of the body operated by compressed air. The disks work in unison and are weighted in order better to grip the ice. The bottom of the body is made watertight so that in the event of the machine breaking through the ice it will float upon the surface of the water. In that case the spirals would act as propellers.

The Lake Calhoun machine, which is unfinished and rough in appearance, was constructed to make an estimated speed of 9 miles an hour; but on its trial trip it easily traveled at the rate of 18 miles an hour. Obstacles and rough places were passed with surprising ease. A toboggan slide course of ice and snow several feet above the level of the lake ice was surmounted without difficulty while traveling at full speed.

SUGGESTED IMPROVEMENTS IN THE AUTOMOBILE.

An automobile which answers the requirements of doctors' use in the country must be a very reliable machine. That the present types of automobiles do not in all respects answer these requirements is pretty well known, notwithstanding the fact that many doctors are using them with satisfaction where the roads are in good repair. A paper was read by Dr. Hard before the Southern Minnesota Medical Society and published in the *Horseless Age* in which the author points out some of the features of the modern automobile which, in his opinion, could be changed with profit. One of these is the differential in the rear axle by means of which the driving wheels adapt themselves to the difference in distances traveled by the rear wheels in turning curves. This mechanism is intricate, weakens the rear axle, is cumbersome and expensive. It has many objectionable features and is the cause of much trouble. It reduces the clearance over the middle of the road to eight inches in most of the automobiles now in use. This is not sufficient to clear many of the stones and other obstructions found so frequently in the middle of country roads. To strike one of these means disaster to the machine, with great delay and expense. When a differential gear is used the axle is made in two pieces, greatly reducing the strength, while it increases the weight and structural difficulties. The tendency to skid on slippery roads is largely due to the action on the drive wheels produced by the differential, the differential making the traction of one wheel depend upon the adhesion

of the other drive wheel to the ground. In other words, if one drive wheel requires twenty pounds of force to make it slip in the mud, the other drive wheel cannot exert that amount of force on the dry ground to help the machine out of the mud-hole. The excess of power is wasted in making the slipping wheel spin around, because of the fact that each drive wheel depends upon the opposition of its fellow for its tractive power. The doctor's ideas for obviating the differential are as follows: Have the drive wheels run free on a solid axle and get their power by independent chains from small sprockets engaged by cone clutches on the ends of the main shaft. In turning a corner or curve, deflection of the front wheels from straightaway to the extent of 12 degrees by the steering machanism results in automatically releasing one of the clutches, so that one drive wheel runs free while the other propels the carriage around the corner. As the front wheels straighten, the clutch again engages, and both drive wheels act equally to propel the carriage. This is a very simple arrangement, and provides for all the advantages of the differential without its presence nor any of its troubles.

WHAT IS AN ALLOY?

Prof. A. Humboldt Sexton, in the Mechanical Engineer, January 27, 1906.

When two or more metals are melted together they, as a rule, remain intimately mixed, showing little tendency to separate according to their density, or as it may be otherwise expressed, they remain in solution one in the other while they are in the liquid condition. When the mass solidifies this state of uniform distribution or mixture may continue, or it may be broken up. In the former case the solidified mass will contain the constituent metals in a condition of more or less uniform diffusion, and such a mass is called an alloy. In the latter case the metals will separate according to their specific gravity, the heavier metal going to the bottom and the lighter rising to the top, such separation being as a rule the more complete the slower the solidification. The separated metals in this case are rarely if ever pure, but each retains a small quantity of the other, and strictly speaking both are therefore alloys. In practice, however, the term alloy is restricted to those cases in which neither of the metals is present in very small proportion; the other cases being simply considered as metals containing an impurity.

An alloy is, then, an intimate mixture of two or more metals, and the term mixed metals has sometimes been used in place of alloys. This is, however, very misleading, as the alloys are much more than mere mixtures, and mixtures of metals may exist which are not alloys.

If lead and copper be melted together, and the mixture be slowly cooled, the metals will separate. If, however, the mixture be quickly cooled separation cannot take place and the metals will remain mechanically mixed the one with the other, they not having had time to separate into distinct layers, but the mass will consist of intermixed particles of the two metals, and if it be heated up to the melting point of lead this metal may be, to a large extent, melted out. This would be a case of a mixture of metals, but not of an alloy. In an alloy the mixture must be of such a character that the constituent metals lose their individuality, and become blended into a new substance which has properties, to some extent at least, unlike that of its constituents.

As a rule, substances which are not elements are divided into the two classes, chemical compounds and mechanical mixtures, but the metallic alloy cannot be made to fit exactly into either group. In a mere mixture the particles, however small and however intimately they may be mixed, always retain their individuality, and the properties of the mixture are always a mean of that of its constituents. If the constituents be black and white the mixture will be grey, if red and white, a paler shade of red, and so on through all the other properties. This, as is well known, is not the case with alloys. Brass containing, say, 50 per cent of copper and 50 per cent of zinc, is yellow, and this yellow color is certainly not a mean between the red of the copper and the bluish white of the zinc; nor is it specific gravity, or indeed any other property, a mean between those of its constituents. The only point in which alloys always resemble their constituents is in the fact that they are distinctly metallic.

Alloys, then, are not mechanical mixtures.

A chemical compound contains the elements in fixed proportions, these being always simple multiples of the atomic weights, and some of the physical properties follow from the molecular weight of the compound. This is not the case with alloys. As a rule, the metals are not present in any simple atomic proportion, and further the proportions can be varied within, often, wide limits without producing any serious change in the properties of the alloy.

The metals do not show any strong chemical affinity one for another, but there is no doubt that in some cases definite chemical compounds of the metals do exist, but in no case do they form alloys of any industrial importance.

Solutions.—There is still another form in which substances can exist which, while not a mere mechanical mixture, is something less than chemical combination. If salt or any other soluble substance be stirred up with water it disappears, or dissolves in the water, and the result is a solution of the salt. This solution has some of the properties of the salt; it has, for instance, a salt taste, yet its properties cannot be said to be a mean between those of water and salt. The salt dissolves without increasing the volume of the solution, so that the solution is denser than the mean between salt and water. The addition of the salt also lowers the freezing point of the water, so that the freezing point of the solution, instead of being a mean between that of water and salt, is lower than that of either, and by the addition of proper proportions of salt may be reduced to about — 22.5 degrees C.

The essential character of a solution is that the constituents are so intimately mixed, probably the mixture being actually molecular, that they cannot be separated or detected by mechanical means, while at the same time they have not entered into true chemical combination.

As a rule, when a solution is solidified, the constituents separate one from another to a larger or smaller extent, but this is not always the case. We can imagine a solution to become solid, and the result would then be a solid solution in which the bodies would still be so intimately mixed that no mechanical separation would be possible, and in which the properties would not be a mean of those of its constituents, but in which these constituents would not be present in the definite proportions required for a chemical compound.

True alloys are never mere mechanical mixtures of metals. Though in some cases the metals do combine, yielding definite chemical compounds, none of these compounds are of any use in the arts. Alloys are very frequently solid solutions of one metal in another, or of a chemical compound of the metals in the metal which is in excess. Many consist of mixtures of such solutions with definite substances that have crystallized out during cooling, so that the actual composition and structure may vary very widely; and each alloy, or rather group of alloys, must be studied separately, as it is impossible to lay down any except the most general rules.

WHY BRASS VALVES LEAK.

The manufacturers of the best brass valves, we believe, test each valve under hydraulic pressure before it is sent out from the factory, yet they frequently leak when erected in the pipe lines. A recent issue of the *Valve World* tells some of the reasons for this fault and shows that it is due to the misuse of the erector in most cases. The points are well worth remembering and may be profitably used in the instruction of apprentices and the older men too, perhaps. The following are the principal bad practises to be avoided:

1. Screwing a valve on a pipe very tightly, without first closing the valve. Closing the valve makes the body much more rigid and able to withstand greater strains and also keeps the iron chips, pipe cement, etc., from lodging under the seats, or in the working parts of valves. This, of course, does not apply to check valves.

2. Screwing a long mill thread into a valve. The threads on commercial pipes are very long and should never be screwed into a valve. An elbow or tee will stand the length of thread very well, but a suitable length thread should be cut in every

case on the pipe, when used to screw into a valve. If not, the end of pipe will shoulder against the seat of valve and so distort it that the valve will leak very badly.

3. The application of a pipe wrench on the opposite end of valve from the end which is being screwed on pipe. This should never be done as it invariably springs or forces the valve seats from their true original bearing with the disks.

4. Never place the body of a valve in the vise to remove the bonnet or center piece from a valve as it will squeeze together the soft brass body and throw all parts out of alignment. To properly remove the bonnet or center piece from a valve, either screw into each end of the valve a short piece of pipe and place one piece of the pipe in the vise, using a wrench on the square of bonnet; or if the vise is properly constructed, place the square of the bonnet in same and use the short piece of pipe screwed in each end as a lever. When using a wrench on square of bonnet or center piece, we recommend the use of a Stillson or Trimo wrench with a piece of tin between the teeth of the jaws and the finished brass. It may mark the brass slightly, but this is preferable to rounding off all the corners with an old monkey wrench which is worn out and sprung. As the threads on all bonnets or center pieces are doped with litharge or cement, a sharp jerk or jar on the wrench will start the bonnet much more quickly than a steady pull. Under no circumstances try to replace or remove the bonnet or center piece of a valve without first opening the same wide. This will prevent bending the stem, forcing the disk down through the seat or stripping the threads on bonnet where it screws into body. If found impossible to remove bonnet or center piece by ordinary methods, heat the body of valve just outside the thread. Then tap lightly all around the thread with a soft hammer. This method never fails, as the heat expands the body ring and breaks the joint made by the litharge or cement.

5. The application of a large monkey wrench to the stuffing box of valve. Many valves are returned with the stuffing boxes split or the threads in same stripped. This is caused by the fitter or engineer using a large sized monkey wrench on this small part.

6. The screwing into a valve of a long length of unsupported pipe. Say, for example, that the fitter is doing some repair work and starts out with a run of 2-inch horizontal pipe from a 2-inch valve connected to main steam header. The pipe is about 18 feet long, and after he has screwed the pipe tightly into valve, he leaves the helper to support the pipe at the other end, while he gets the hanger ready. The helper in the meantime has become tired and drops his shoulder on which the pipe rests about 3 inches and in consequence the full weight of this 18-foot length of pipe bears on the valve. The valve is badly sprung and when the engineer raises steam the next morning the valve leaks. When a valve is placed in the center of a long run of pipe, the pipe on each side, and close to the valve, should be well supported.

7. The use of pipe-cement in valves. When it is necessary to use pipe cement in joints, this mixture should always be placed on the pipe thread which screws into valve, and never in the valve itself. If the cement is placed in the valve, as the pipe is screwed into valve it forces the cement between the seats and discs, where it will soon harden and thus prevent the valve from seating properly.

8. Thread chips and scale in pipe. Before a pipe is screwed into a valve, it should be stood in a vertical position and struck sharply with a hammer. This will release the chips from thread cutting, also loosen the scale inside of pipe. When a pipe line containing valves is connected up, the valves should all be opened wide and the pipe well blown out before they are again closed. This will remove foreign substances which are liable to cut and scratch the seats and disks.

9. Expansion and contraction. Ample allowance must be provided for expansion and contraction in all steam lines, especially when brass valves are included. The pipe and fittings are much more rigid and stiff than the brass valves and in consequence the expansion strains will relieve themselves at the weakest point, unless otherwise provided for.

10. The use of wrenches or bars on valve wheels to close same tightly. This should never be done as it springs the entire valve and throws all parts out of alignment, thus making the valve leak. The manufacturer furnishes a wheel sufficiently large to properly close against any pressure for which same is suitable. If the valves cannot be closed tightly by this means, there is something between the disks and seats or they have been cut or scratched by foreign substances.

THE FUTURE OF THE AUTOMOBILE.

Abstract of article by Mr. Winthrop E. Scarritt, in Cassier's Magazine, March, 1906.

The American car to-day closely follows the general lines of the French automobile. It is a well-known fact that the so-called gasoline car, or internal combustion motor, has almost displaced the steam type. There is only one steam car on the American market that has demonstrated its practicability. In gasoline automobiles, multiple cylinders are the rule. There are makers who are beginning to manufacture even six-cylinder cars, and these are found to be quite successful. The shaft-driven car is also largely taking the place of the chain drive. Formerly, it was thought that the shaft drive could not be used for the large car, but the success of the shaft-driven cars more recently has demonstrated the fallacy of this idea.

The principal criticism which has been made of American cars heretofore—which statement is not confined to American cars alone—is that they are unreliable. The idiosyncrasies of the gas engine are well known. It sometimes takes an expert an hour to discover a slight trouble, which when found may be remedied in five minutes. Through better material, better workmanship, and close attention to details and adjustment, the motor cars have become far more reliable than they were two years ago. It is now an exception to see an automobile laid up on the highway for anything except tire troubles, and even these are far less frequent than they were formerly. This comes about through two facts—the tire makers are putting better material into their products, and the manufacturers of automobiles are insisting on the use of a larger tire for a given weight than heretofore.

Edison has pointed out a strange paradox in the automobile. He says that the only thing which makes the automobile possible and practicable is the pneumatic tire, and at the same time the pneumatic tire is the weakest point in the automobile. The solid rubber tire, while successfully used on commercial vehicles at slow speeds, has not been, and cannot be, successfully used on touring cars or racing machines. The writer has made some experiments along this line, and has found that the jar and hammer incident to driving a touring car over rough roads are so great that the machinery of the motor car will not stand the shocks and strains.

The fuel problem is becoming a serious one for the automobilist. Within the past ten years, the demand for gasoline has increased enormously, and the price has almost doubled, while the supply has increased but little. The oil fields of Texas and California do not furnish the kind of oil from which gasoline can be manufactured. It is a fact not well known that the farmers of America use more gasoline than the automobilist. Eight hundred thousand gasoline stoves are in use throughout the western portion of the United States where fuel is high in price. The supply of gasoline within five years or less will be entirely inadequate to the demand, and the price will necessarily advance to prohibitive figures.

The most practical solution of the matter is to secure the passage of an act by Congress taking off the tax on denaturized alcohol used for commercial purposes. This is now being agitated. The present tax is $2.08 per gallon [95 per cent alcohol or the equivalent of 1.9 "proof" gallons]. Vegetable alcohol may be made from corn, beets, potatoes—in fact, from any of the starchy products. It can be made and sold at a price which is no greater than that now paid for gasoline. Last year over two hundred million gallons of vegetable alcohol were used in Germany.

The standard car of the future, whether for pleasure or business, will be of the gasoline type. It will be simple, and will be constructed of the highest grade of material known to the art. Reliability rather than speed will be the great desideratum. It will become standardized, and when standardized it can be made in large quantities at a low cost. I believe the automobile, so far as cost is concerned, will follow

the way of the bicycle. In the near future I expect to see a very fair runabout sold for $300, and the same grade of touring car for $500.

In conclusion, it may be well to consider some problems which are to be solved by this new factor in civilization. First, it will tend to prevent traffic congestion in city streets. A single example: What would it be worth if Broadway, New York's main thoroughfare, could be doubled in width from its lower end for a distance of, say, nine miles? Broadway is no wider than it was a hundred years ago, and yet the traffic upon this highway is a hundredfold greater than it was then. A horse driven truck starting from one end will make the nine-mile trip in two hours, carrying a load of a ton and a half. Substitute the motor truck and what follows? The space occupied by the horse, which is about equal to that of the truck, is saved. Further, the motor car will carry three tons, and can make the trip in just half the time of the horse-drawn vehicle. Thus, it is seen that the use of the motor vehicle would not only double, but more than treble, in effect, the width of the street.

Second, the automobile will tend to solve the tenement house problem. Automobiles ultimately will be built and sold at so low a cost that the average city workman will be able to own one, as he now owns his bicycle. Thus, he will be enabled to own his acre, away in the country, and bring up his children in the sunshine and fresh air among far more pleasant and healthful surroundings than are possible in the crowded tenement house districts of large cities.

Third, the use of the automobile in country districts will tend to keep the young people from flocking to the cities. The automobile will make life on the farm more pleasant. Young people will be able to go about visiting neighbors and friends even in adjoining counties, and in the future we shall probably hear less of "abandoned farms."

Fourth, the automobile will become indispensable to the physician, and I have no doubt that countless human lives will be saved, because, through the use of the motor car, the physician will be enabled to reach patients in a critical condition more quickly than by any other available means. The automobile will also become invaluable to firemen, to officers of the law, and to others in situations where great speed of transit is a desideratum.

TESTS OF HIGH-SPEED TOOL STEELS ON CAST IRON.

Abstract from Pamphlet issued by the Illinois Engineering Experiment Station, at the University of Illinois.

In the report, from which the following abstract is taken, are described experiments conducted under the direction of Prof. L. P. Breckenridge of the University of Illinois. The experiments were made by Mr. H. B. Dirks, Assistant in Mechanical Technology, Engineering Experiment Station, in the shops of the College of Engineering at the University of Illinois. These experiments have been in progress for nearly a year.

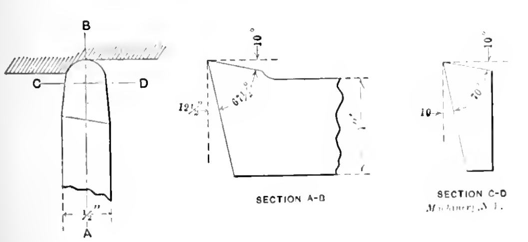


Fig. 1. The Shape of the Tool.

I. The Tool Steel Used.

The Brands Used.—The following tool steels were used in these trials:

1. Styrian marked "Böhler Rapid."
2. Jessop's "Ark."
3. McInness's "Extra."
4. Mushet's "Special."
5. "Air Novo."

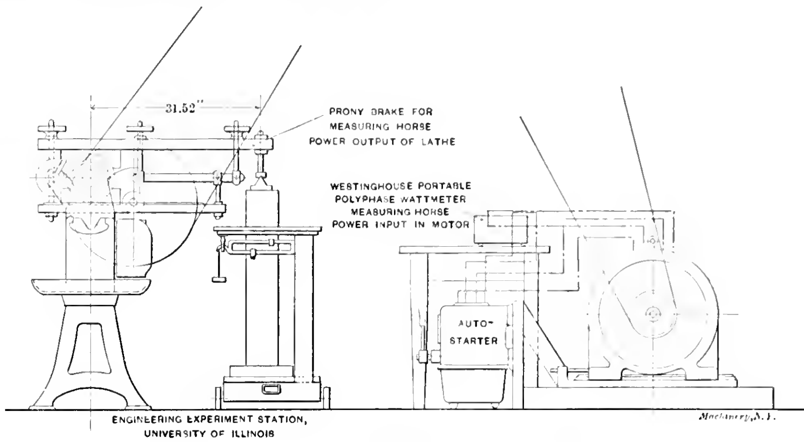


Fig. 2. Arrangement of Brake and Driving Mechanism.

6. "Rex."
7. "Poldi."
8. "A. and W" (Armstrong and Whitworth).

Size and Shape of Tools.—The size of the bars of steel from which the tools were made was ½ inch by 1 inch for the steels from the American market. The Poldi bar was ¾ inch by 1¾ inch, and the "A. and W" bar was ¾ inch by 1¼ inch. The shape of the tool used in the tests is shown in Fig. 1. The

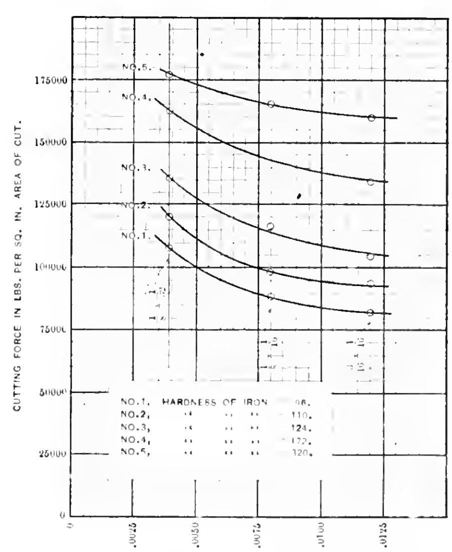


Fig. 3. Relation between Cutting Force on Point of Tool and Area of Cut

front clearance was 12½ deg., the top rake was 10 deg., and the side rake was also 10 deg. Experiments relating to the proper shape of tools have been made by Professor J. T. Nicolson, and the writers were guided in selecting proper tool angles by the recommendations of his paper. Professor Nicolson says: "Tools should therefore be ground for maximum endurance in the cutting of cast iron in ordinary shop practice so that their true cutting angles are about 81 deg., or if they are allowed 6 deg. clearance for working on the level of the lathe centers, they should have an included angle of about 75 deg.

II. The Cast Iron Test Pieces.

In order that the results of the tests might be of general application, it was advisable that the cast-iron test pieces be the

product of several commercial foundries. Several manufacturers throughout the State agreed to furnish sample test pieces representing the grade of cast iron used in their respective foundries. A standard size of test piece was therefore decided upon, and blue prints and patterns of it sent to the different manufacturers. The outer diameter is 9 inches, the maximum the lathe will swing over the carriage, and 27 inches long. This test piece was made hollow for several reasons. A solid test piece becomes soft toward the center and is more likely to contain blow holes. Test pieces of small diameter become springy and consequently produce inaccuracies in the results. The high angular velocity necessary with small diameters is also undesirable. Some other test pieces not conforming to the standard were used, however.

A comparative hardness test was made on all samples, comparison being made with a standard piece of soft cast iron of equal density throughout, the chemical analysis of which is as follows:

Combined Carbon	= .147%	Manganese	= .33 %
Graphite	= 5.03 %	Sulphur	= .07 %
Silicon	= 2.35 %	Phosphorus	= 1.06 %

The hardness of cast-iron or any other metal as indicated by a drill test is probably as fair an indication of the particular quality of the metal that affects the cutting speed as is obtainable by any process in use at the present time. This hardness test is in itself a cutting-speed test in which the cutting speed is not varied, but is held constant and the rate of feed allowed to vary, the cutting speed and rate of feed in all probability bearing some constant relation to each other. The tests were made with a drill press on the spindle of which

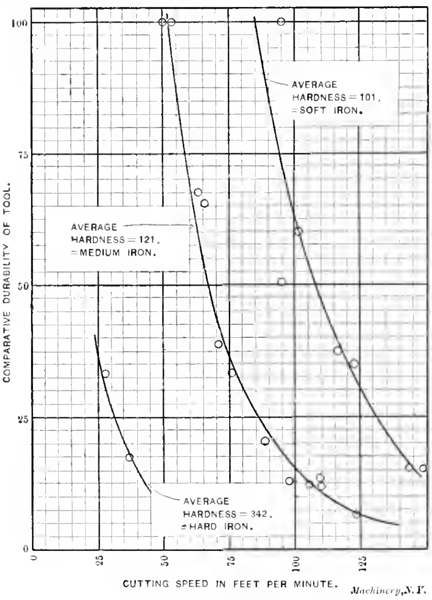


Fig. 4. Variation of Durability of Tool for Different Speed and Grade of Iron.

a constant load of 312 pounds was applied by means of the weighted lever. With the spindle rotating at a constant speed of 87 revolutions per minute, the rate of feed of the drill in inches per minute was measured, readings being taken for every ¼ inch of depth drilled. The drill used in these tests was a Morse standard ½-inch twist drill ground to an angle of 62½ deg. As, however, there was some liability of variation in the sharpness of the drill, thus affecting its rate of feed, a uniform piece of cast iron was first drilled into, readings taken, and then the test made on the test piece. A comparison was thus always made with this same piece of cast iron, eliminating any small variation in the sharpness of the drill. Thus, in one test the rate of feed is about .174 inch per minute, while in drilling the standard cast iron, the rate of feed is about .595 inch per minute. The hardness is thus expressed by the ratio $\frac{.595}{.174} \times 100 = 342$. The hardness of the standard cast iron is expressed by 100.

III. Details of the Tests.

Apparatus.—The apparatus used in conducting the tests consisted mainly of a high-speed lathe deriving its power from a two-phase induction motor by means of belting and a countershaft, the power required being measured by a polyphase wattmeter. The lathe was a Pratt and Whitney high-speed lathe with a gear box head-stock, taking a maximum length of 3 feet 9 inches between centers and a diameter of 9 inches over the carriage. The lathe has cone gears from which power is transmitted either direct to the spindle or through back gears, making 8 changes in speed. The feed mechanism is positive with 8 changes also.

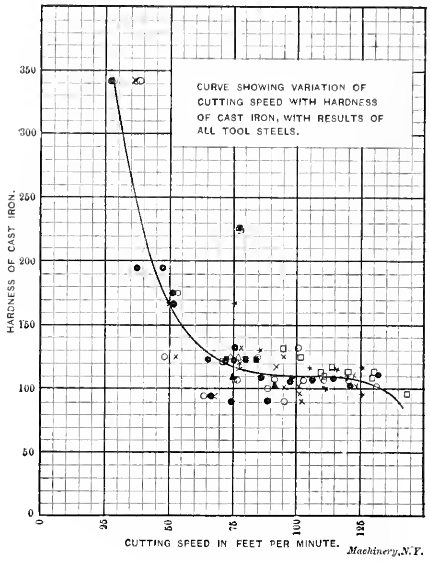


Fig. 5. Curves showing Proper Cutting Speeds of Iron of Varying Hardness

The power was transmitted to the lathe by means of a 4-inch double belt from the 12-inch friction clutch pulley of the countershaft. The countershaft in turn was driven through a 37-inch pulley by a 4-inch single belt from the motor. The motor is on an adjustable base, allowing changes of the motor pulley to be made without changing the length of the belt. In the tests, pulleys ranging from 6 to 12 inches in diameter were used, making possible with the 8 changes of speed on the lathe proper, 56 changes for every diameter of work. As the diameter of the test piece decreased, it was thus possible to keep the speed of the cut constant within very small limits.

Procedure in Making the Tests.—In the preliminary trials the skin was first removed to bring the test piece to a uniform diameter throughout. This was discontinued in the later trials and a separate series of skin cut trials was run. The test piece having been made ready for the test, the tool to be used was placed in the tool rest in the position decided upon for all tools and trials, viz., at right angles to the work with the bottom edge of the tool horizontal and the cutting edge of the tool from ⅛ inch to ¼ inch above the center of the work, its exact position being recorded in the log. The diameter of the test piece was then accurately measured in several places and the average recorded in the log. The tool was then fed in by hand until the cutting edge just scraped the bottom of the groove left by the last turning. The graduated disk on the cross feed having been set at zero, with the tool in the above position, the cross feed was turned back a little, and the carriage moved to the right sufficiently for the tool to clear the test piece. The cross feed was then advanced until the graduated disk showed the required cut opposite the index mark. The longitudinal feed or traverse was then set in position and recorded in the log. The diameter of the work and the surface speed required during the trial being known, the size of the pulley to be used on the motor and the position of the driving gear necessary to give the required speed were obtained from a set of curves giving the speed for various diameters of work for each of the 56 changes obtainable. This

having been done, the lathe was started and the surface speed tested with a Warner cutmeter. When the right conditions were finally attained, the lathe was stopped on a full cut, the revolution counter set at zero, the lathe cleared of chips, and the test started. After the expiration of the trial, which occurred either at the time of failure of the tool or at a specified time limit, the tool was withdrawn and the lathe run light under the same conditions of speed as in the trials, in order to observe the electrical horse-power exerted by the motor under these conditions. All the cuttings were then collected, weighed and recorded in the log.

Description of Methods Adopted for Measuring the Force Required in Cutting.—During the trials readings were taken at regular intervals of the total electrical watts input in the motor, while cutting, and after the tool had been withdrawn, with the lathe running light. The difference between the electrical horse-power with the tool cutting and with the lathe running without the cut should give the net horse power required for cutting, and if this be multiplied by 33,000 and divided by the cutting speed, we obtain the force required for cutting in pounds. In thus figuring, we assume that the lost horse-power of the drive remains constant from no load to full load. To determine whether or not this was the case, a Prony brake was placed on the cast-iron test piece, as shown in Fig. 2. This could be made to offer the resistance otherwise produced by the cutting tool, and this resistance could be measured at the end of the brake arm by observing the reading on the scale beam of the platform scales.

IV. Summary of Results.

Variation of Cutting Force with Area of Cut.—The effort exerted by the tool in cutting was determined as explained in Part III. The horse power lost in driving the lathe and countershaft was deducted from the total horse power used during the trial, the difference being the net horse power required for cutting. This was reduced to foot-pounds per minute, and divided by the cutting speed, giving the force exerted. The figures so obtained were reduced to pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in Fig. 3. The curves show that the cutting force was not directly proportional to the area of cut, but decreased as the area increased, and that the average cutting force varied from 50 tons per square inch for soft cast iron to 85 tons per square inch for hard cast iron.

Variation of Durability of Tool with Cutting Speed.—An entirely arbitrary standard of durability was established as follows: A tool whose cutting edge was worn away .002 inch after an hour's use was considered perfect, its durability being expressed as 100. The ratios of the durability of any other tools to the standard will then be the inverse of the ratios of their rates of wear to the rate of wear of the standard.

In Fig. 4 are shown the curves which represent the relation between the durability of the tool and the cutting speed. These are important curves. Each curve represents a different hardness of cast iron. Referring to the middle curve, which is for cast iron of medium hardness, it will be seen that a cutting speed of 50 feet per minute is satisfactory, the durability being 100. If the speed is increased very materially, the durability decreases quite rapidly. It is evident that for each hardness of cast iron, the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

Variation of Cutting Speed with the Hardness of Cast Iron. —The curve shown in Fig. 5 represents the advisable cutting speed on cast iron of varying hardness. This curve represents the result of all the tests of the different steels tested. This curve shows: (a) that any of the steels tested can remove very hard cast iron at a rate of 25 feet per minute; (b) that all of the steels tested begin to wear rapidly at speeds a little above 125 feet per minute. Between these two points the relation between a safe cutting speed and the hardness of the cast iron seems to be definitely expressed by the curve It would seem that cast iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 feet per minute, so far as any injury to the tool is concerned. It must be remembered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly 1/8 inch depth of cut by 1-16 inch feed, so that there is but a slight variation in the area of cut in all of the experiments. From the curve of Fig. 5 we find the cutting speed given in the table below to be applicable to the grades of iron manufactured by the different companies sending test pieces. In order that any company may make use of the curve shown in this figure, it will be necessary simply to determine the average hardness of its cast iron, as explained elsewhere, and where the horizontal line representing this hardness cuts the curve, the possible safe cutting speed may be read on the scale below. This curve should prove useful to various manufacturers.

Allowable Cutting Speeds for Grades of Cast Iron used in the Tests.

Average Hardness Test Pieces.	Allowable Cutting Speed.	Average Hardness of Test Pieces.	Allowable Cutting Speed.
101.8	132.0	103.1	132.0
110.7	118.0	132.0	63.0
109.3	120.0	313.0*	28.0
112.7	90.0	175.2	48.0
138.1	60.0	136.3	60.0

* Ferro-steel.

(*d*) Generally speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full benefit however, certain advances must be made. Heavier machine tools must be built. The capacity of the motors and power plant must be increased. Special hardening furnaces with temperature measuring devices must be available. More must be known concerning the chemical and physical properties of the various steels.

PENNSYLVANIA RAILROAD SYSTEM LOCOMOTIVE TESTS.*

One of the chief features of the railroad exhibit at the Louisiana Purchase Exposition was the elaborate testing plant of the Pennsylvania Railroad System where eight locomotives of various types, four freight and four passenger, were exhaustively tested during the exposition period, as follows:

No. 1. Pennsylvania R. R., consolidation type, simple, wide firebox.

No. 2. Lake Shore & Michigan Southern R. R., consolidation type, simple, with wide firebox.

No. 3. Michigan Central, consolidation type, cross-compound, wide firebox.

No. 4. Atchison, Topeka & Santa Fe, Santa Fe type, tandem compound (decapod with trailer).

No. 5. Pennsylvania R. R., Atlantic type, 4-cylinder balanced compound (De Glehn).

No. 6. Atchison, Topeka & Santa Fe, Atlantic type, 4-cylinder balanced compound.

No. 7. Hanover Locomotive Works, Atlantic type, 4-cylinder balanced compound, with superheater.

No. 8. New York Central & Hudson River R. R., Atlantic type, 4-cylinder, balanced compound.

The plan, scope and details of the testing plant and of the tests were presented to the public from time to time in the form of pamphlets, and now the complete account of the work has been published in book form, together with comparisons and conclusions and a summary of conclusions. That the volume is one of exceedingly great value goes almost without saying. The following is the summary of conclusions of the work, which it will be seen gives in small compass facts of much significance:

Boiler Performance.

1. Contrary to a common assumption, the results show that when forced to maximum power, the large boilers delivered as much steam per unit area of heating surface as the small ones.

2. At a maximum power, a majority of the boilers tested, delivered 12 or more pounds of steam per square foot of heat-

* The Pennsylvania Railroad System Tests and Exhibits at the Louisiana Purchase Exposition. 733 pages, 6 x 9 inches, 817 cuts and folding plates and about an equal number of indicator and dynamometer diagrams and plottings of observations Published by the Pennsylvania Railroad System and for sale by D. L. Newhall, purchasing agent, P. R. R., Philadelphia, Pa. Price, $5.00

ing surface per hour; two delivered more than 14 pounds; and one, the second in point of size, delivered 16.3 pounds. These values expressed in terms of boiler horse power per square foot of heating surface are 0.34, 0.40 and 0.47 respectively.

3. The two boilers holding the first and second place with respect to weight of steam delivered per square foot of heating surface, are those of passenger locomotives.

4. The quality of steam delivered by the boilers of locomotives under constant conditions of operation is high, varying somewhat with different locomotives and with changes in the amount of power developed, between the limits of 98.3 per cent and 99.0 per cent.

5. The evaporative efficiency is generally maximum when the power delivered is least. Under conditions of maximum efficiency, most of the boilers tested evaporated between 10 and 12 pounds of water per pound of dry coal. The efficiency falls as the rate of evaporation increases. When the power developed is greatest, its value commonly lies between limits of 6 and 8 pounds of water per pound of dry coal.

6. The observed temperature of the fire-box under low rates of combustion lies between the limits of 1,400 degrees F. and 2,000 degrees F., depending apparently upon characteristics of the locomotive. As the rate of combustion is increased, the temperature slowly increases, maximum values generally lying between the limits of 2,100 and 2,300 degrees F.

7. The smoke-box temperature for all boilers, when worked at light power, is not far from 500 degrees F. As the power is increased, the temperature rises, the maximum value depending upon the extent to which the boiler is forced. For the locomotives tested, it lies in most cases between 600 and 700 degrees.

8. With reference to grate area, the results prove beyond question that the furnace losses due to excess air are not increased by increasing the area. In general, it appears that the boilers for which the ratio of grate surface to heating surface is largest are those of greatest capacity.

9. A brick arch in the fire-box results in some increase in furnace temperature and improves the combustion of the gases.

10. The loss of heat through imperfect combustion is in most cases small except as represented by the discharge from the stack of solid particles of fuel.

11. Relatively large fire-box heating surface appears to give no advantage either with reference to capacity or efficiency. The fact seems to be that the tube heating surface is capable of absorbing such heat as may not be taken up by the fire-box.

12. The value of the Serve tube over the plain tube of the same outside diameter, either as a means for increasing capacity or efficiency, was not definitely determined.

13. The draft in the front end for any given rate of combustion as measured in inches of water, depends upon the proportions of the locomotive and the thickness and condition of the fire. Under light power, its value may not exceed an inch, but it increases rapidly as the power is increased. Representative maximum values derived from the tests lie between the limits of 5 and 8.8 inches.

14. Insufficient openings in the ash pan and the mechanism of the front end, especially the diaphragm, are shown by the tests to lead to the dissipation of considerable portions of the draft force.

The Engine.

15. The indicated horse power of the modern simple freight locomotive tested, may be as great as 1,000 or 1,100; that of a modern compound passenger locomotive may exceed 1,600 horse power.

16. The maximum indicated horse power per square foot of grate surface lies, for the freight locomotives, between the limits of 31.2 and 21.1; for the passenger locomotives, between the limits of 33.5 and 28.1.

17. The steam consumption per indicated horse power hour necessarily depends upon the conditions of speed and cut-off. For the simple freight locomotives tested, the average minimum is 23.7. The consumption when developing maximum power is 23.8 and when under those conditions which proved to be the least efficient, 29.0.

18. The compound locomotive tested, using saturated steam, consumed from 18.6 to 27 pounds of steam per indicated horse power hour. Aided by a superheater, the minimum consumption is reduced to 16.6 pounds of superheated steam per hour.

19. In general, the steam consumption of simple locomotives decreases with increase of speed, while that of the compound locomotives increases. From this statement it appears that the relative advantages to be derived from the use of the compound diminish as the speed is increased.

20. Tests under a partially opened throttle show that when the degree of throttling is slight, the effect is not appreciable. When the degree of throttling is more pronounced, the performance is less satisfactory than when carrying the same load with a full throttle and a shorter cut-off.

The Locomotive as a Whole.

21. The percentage of the cylinder power which appears as a stress in the draw-bar, diminishes with increase of speed. At 40 revolutions per minute, the maximum is 94 and the minimum 77; at 280 revolutions per minute, the maximum is 87 and the minimum 62.

22. The loss of power between the cylinder and draw-bar is greatly affected by the character of the lubricant. It appears from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

23. The coal consumption per dynamometer horse power hour, for the simple freight locomotive tested, is at low speeds not less than 3.5 pounds nor more than 4.5 pounds, the value varying with running conditions. At the highest speeds covered by the tests, the coal consumption for the simple locomotives increased to more than 5 pounds.

24. The coal consumption per dynamometer horse power hour, for the compound freight locomotives tested is, for low speeds, between 2.0 and 3.7 pounds. Results at higher speeds were obtained only from a two-cylinder compound, the efficiency of which under all conditions is shown to be very high. The coal consumption per dynamometer horse power hour for this locomotive at the higher speeds increases from 3.2 to 3.6 pounds.

25. The coal consumption per dynamometer horse power hour for the four compound passenger locomotives tested, varies from 2.2 to more than 5 pounds per hour, depending upon the running conditions. In the case of all of these locomotives, the consumption increases rapidly as the speed is increased.

26. A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the draw-bar, the poorest compound shows a saving in coal over the best simple which will average above 10 per cent, while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provide for the continuous operation of the locomotives at constant speed and load throughout the period conveyed by the observations, are all favorable to the compound.

27. It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the draw-bar upon the consumption of but a trifle more than 2 pounds of coal per hour. This fact gives the locomotive high rank as a steam power plant.

28. It is worthy of mention that the coal consumption per horse power hour developed at the draw-bar by the different locomotives tested presents marked differences. Some of these are easily explained from a consideration of the characteristics of the locomotives involved. Where the data is not sufficient to permit the assignment of a definite cause, there can be no doubt but that an extension of the study already made will serve to reveal it.

* * *

For most ordinary purposes, Prof. Carpenter recommends babbitt metal as being a satisfactory bearing metal, but for more severe conditions he advises a mixture of 50 per cent aluminum, 25 per cent zinc and 25 per cent tin.

NEW METHOD OF FINISHING PISTON RINGS.

A new method of finishing spring piston rings, that is, rings turned larger than the cylinder bore, has been invented and patented (No. 793,276) by Mr. Warren Chambers of Toronto, Ontario, formerly of Beloit, Wis. It was first tried in the works of the Fairbanks-Morse Co., of Beloit, on the piston rings of gas engines. The scheme is illustrated in the accompanying cuts, Figs. 1, 2 and 3, and consists of grinding the periphery of a ring under essentially the same conditions that affect it when in the cylinder of the engine, but before describing it fully it will be of interest to briefly review the conditions affecting the manufacture of piston rings as generally followed.

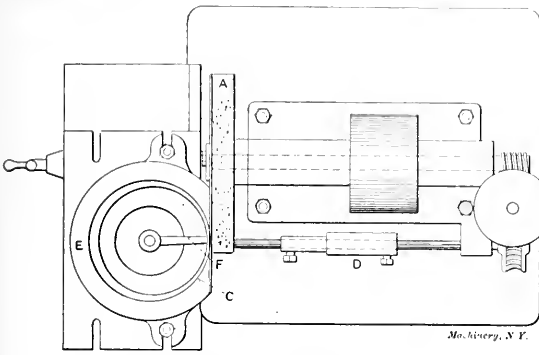


Fig. 1. Plan View of Piston Ring Grinder.

Every mechanic knows that a ring which is turned larger than the bore of the cylinder, whether it be of uniform thickness, bored eccentric or cast to a theoretical tension curve on the inside surface, will not have a uniform tension or bearing on the surface of the cylinder bore until it has been filed or scraped to fit, or let run until it wears itself to a bearing. That the last named method is not good practice is quite obvious. The efficiency of a gas engine to a large extent depends upon the compression it is possible to obtain and if the rings have imperfect bearing, the efficiency under the first working test must be below the standard. Moreover the leak may never take up entirely on account of the destructive scoring effect of the escaping gases on the cylinder walls. To file and scrape a piston ring to a good bearing is a laborious and expensive job, and is one that is usually commercially impractical on account of the keen competition in this field of manufacture.

One method of obtaining an approximately close fit is to spring the ring down nearly to the cylinder diameter and

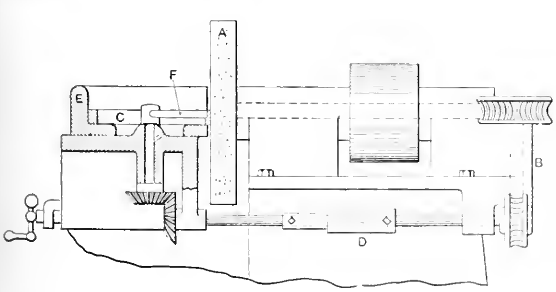


Fig. 2. Driving Mechanism of Grinder.

clamp it between collars or flanges; then having removed the form a light cut is taken over the periphery. This method is a decided improvement over the "fitting by hand" method but it is by no means a perfect job, for it will leak, the simple reason being that taking a cut over the surface, which necessarily takes off more stock in some places than in others, changes the tension of the ring and the distribution of the metal so that as soon as the clamp collars are removed it alters shape. To prove this put it in the cylinder, when daylight will invariably be seen between the ring and the cylinder bore. Or, a better test is to spring it down to the size it was last turned to, and after removing the form to test it in a universal grinding machine. The ring will be found to "run out" no matter how many times the operation is repeated. In a series of experiments along these lines on 6-inch rings they were found to be run out when the operation was repeated not less than twelve times. Of course the error was diminished at every grinding but the principle remained the same.

Some manufacturers make their piston rings eccentric with the inside bore, which is left rough for cheapness of production and also to get the benefit of the scale remaining inside; the scale improves the elasticity of the ring and lessens the liability of breaking or distortion when sprung over a solid piston. This method does not produce a perfect bearing ring, although some of the evils of the turned eccentric ring, finished all over, are undoubtedly mitigated thereby.

After going over the various methods of manufacture Mr. Chambers came to the conclusion that there is only one practically perfect method of finishing piston rings, and that is to grind them under the same conditions of shape and tension that they are subjected to in working, and the machine shown was designed with this object in view. It consists of a frame carrying an emery wheel *A* and a form *E* in the center of which latter is a revolving finger *F* driven by suitable worm reduction gearing *B* from the emery wheel spindle. The form *E* is bored smaller than the diameter of the ring to be ground, being of the same diameter as the cylinder, to which it corresponds; various sizes are provided to suit the sizes of the rings to be ground. The table carrying *E* is adjustable relative to the emery wheel, the driving gear shaft having a telescopic sleeve at *D*. One side of the form is cut off tangentially so that about 3/8 inch of, say, a 5-inch ring is exposed

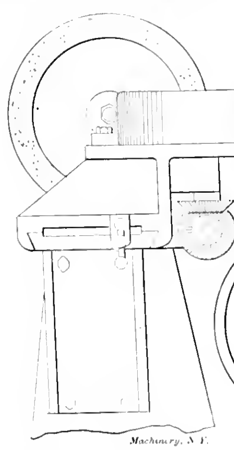


Fig. 3. Front Elevation.

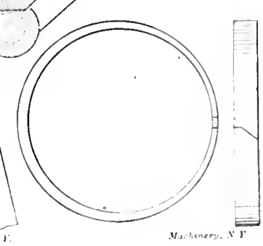


Fig. 4. Design of Ring used

to the emery wheel. The ring, of the type shown in Fig. 4, is sprung into the form with the finger *F* engaged in the cut. The finger slowly revolves the ring while the grinding wheel removes the high spots and these only. As the grinding proceeds the ring changes shape conforming more and more closely to the form until it reaches a practically perfect bearing therein. It makes no difference what the character of the material composing a ring is, its width, hardness or defects such as blowholes, spongy spots, etc.; it will grind to an exact bearing in any case because the ring is free to adjust itself to the changing condition due to the removal of the high spots. Naturally, therefore, Mr. Chambers, who has had many years practical experience in the manufacture of piston rings, believes that he has discovered the only sure way of eliminating the one serious trouble in the manufacture of gas engines. A piston ring finish that will get a "stay-over-night" compression, is produced in this machine easily and cheaply by ordinary labor, and the machine is adapted to a wide range of sizes of rings. It is not confined of course to the production of gas engine piston rings but any kind or style of piston ring required may be produced equally as well. This machine makes it possible to produce chilled piston rings, and, in fact, was designed with this object in view.

When piston rings are to be ground in place in a solid piston so as to avoid the distortion incident to springing them into

the grooves, the form E is made deep enough to receive the whole piston and the driving finger E is removed. The piston is revolved by suitable pins which drive both the piston and its rings, the piston being drilled to receive the driving pins.

* * *

A DISCUSSION OF THE TAYLOR SYSTEM OF SHOP MANAGEMENT.

A feature of the February reunion of the A. S. M. E. held at the society headquarters on the evening of February 27, was the reading of a paper presented by James M. Dodge, of the Link Belt Engineering Co. He described the introduction and present operation of the Taylor system in the shops of his concern. The paper was written in a clear and bright style, which kept the audience interested and at times amused.

Mr. Dodge described the conditions which led to the change in the administration of the Link Belt Engineering Co.'s shops. Reports had come to them from time to time of the remarkable work being done at the Bethlehem Steel Works by the Taylor-White steel, and after watching performances of tools treated by this process and after painfully convincing himself and his tool dresser that the steel had really an efficiency hitherto undreamed of, he eventually obtained a license for its use. Most of the work it had to do in their own shops, however, was in turning cast iron, and it was soon discovered that as originally made the tools, in this material, fell far short of their performance when used on armor plate and nickel-steel forgings at the steel works. A long and costly series of experiments was then entered into, from which finally resulted a steel which gave as good results on cast iron as the original steel did on the more fibrous metals. This was the introduction of the Link Belt Engineering Co. to one of the most important phases of the new method of shop management, namely, the careful scientific investigation of the factors that have to be considered to produce superior commercial results.

It was soon seen that other features in the management of the shop in which much pride had been taken, had lost some of their luster when compared with the standard set by the new steel. For instance, in figuring piece work rates, which had been hitherto done by guess work on the part of "guessers" who were supposed to be as good as any in the country, it was realized that a little mistake one way or the other made more difference when a man was making 200 pieces a day than it did when he was making 50. On realizing the truth of this fact, it was concluded that a scientific rate-setting department was needed. The preceding changes increased the output of the concern to such an extent as to necessitate the altering of the store-room system to meet the demands of the increased business. The receiving room then showed up to such poor advantage in comparison with the stock room that it next succumbed to the wave of reform. The increase in the amount of business was again found to be so great as to overtax the memories of the men who had been responsible for looking out for the details of putting the work through the shops, and finally the entire administration of the plant was so changed as to concentrate the routing of the product in the hands of a separate department, which laid out the work for every man and machine in the establishment.

Defining the new method, Mr. Dodge said: "The Taylor system as I know it, is not a method of paying, a mere question of foremanship, the selection of a pink ticket or a blue ticket in the store room, the specific ruling of a ledger, nor the use of the slide rule universally, or even the use of high-speed steel, or the question of electric or belt drive, or any other one of details which might be multiplied almost indefinitely; it is much broader, better and more far-reaching than any of its parts, however excellent they may be; it is simply an honest, intelligent effort to arrive at the absolute truth in every department, be it agreeable or disagreeable; to let tabulated and unimpeachable fact take the place of individual opinion; to develop team play to its highest possibility; to make it impossible for an incompetent laggard to remain intrenched in his position, whether he be of greater or less importance; to secure to every individual of an organization just recognition of his personal utility and worth; to root out prejudice and make students of us all, with the success of the organization paramount to individual preferment; and to make men work, not harder, but to better advantage."

At the close of the address a number of men rose to their feet and began to ask questions such as: "To how small a shop can the system be applied?" "Are there any varieties of work to which it cannot be successfully applied?" "Can deliveries by this method be successfully figured in advance?" At this juncture Mr. Taylor himself was discovered in the rear of the hall, whence he was persuaded to come forward and give the desired information. The remainder of the meeting was taken up with a rapid fire of question and comment, in the course of which many interesting and valuable suggestions were presented by Mr. Taylor, whose remarks were listened to by the audience with evident appreciation. In regard to the question of the minimum size of the shop to which the system is applicable, he referred to a recent installation in a Philadelphia establishment which employs about 120 men. This he considered to be the minimum limit for a concern doing work of a varied character and was only possible in this case because the product was such that, as the improvements began to take effect, the rate of production could be increased to keep the maximum number of machines at work. On work of an elementary and routine nature a much smaller number of men could use the system to advantage.

Referring to the question as to the varieties of work to which it was safe to apply the system, he considered that there was practically no limit to its usefulness in this direction. In shops where there is much of such work done the grinding of parts to limits of 0.001 inch or, in some instances, 0.00025 inch could be figured on as accurately as the removal of surplus stock from a 13-inch gun forging. Mr. Taylor admitted that the pattern shop presented the toughest proposition in this respect and did not think it advisable to lay out the work of the patternmaker beforehand, as is generally done for the lathe and planer operator. He believes, however, that even this might come within the range of practicability in a place where patternmaking is done on a sufficiently large scale.

Other points were discussed, such as the mental attitude necessary on the part of the management and the employees for the successful working of the system, and the possibility of difficulty with labor unions. Mr. Taylor threw valuable light on all these questions and kept his hearers interested until a late hour.

* * *

A JOKE ON THE OLD MAN.

A. P. PRESS.

We got a joke on the "Old Man" last week that was too good to keep. A joke on one of the boys is all right, but when the "Super" bites it off, it is better still.

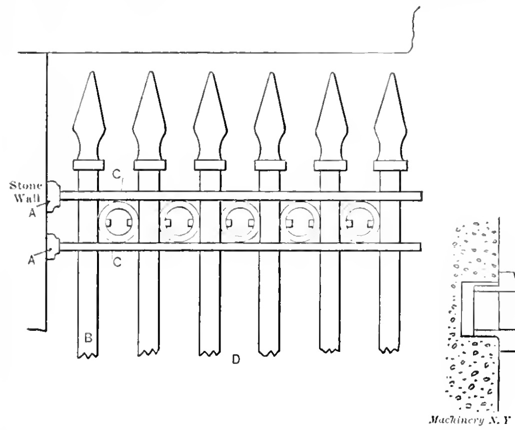
Down at one end of the press-room is a drop-press driven by a rope-lifter. The countershaft is up near the wall, and one end runs through the partition, and the driving pulley is on the other side. Bill was doing a lot of flat dropping and he was making the hammer fly (it was a piece work job). The "Old Man" came into the room and stood watching him. Bill run off a lot, shut off the power and went away from the drop. The "Old Man" did not notice there was a driving belt, in fact he couldn't see it, as it was on the other side of the partition. He went down the room, went up to the drop and tried to raise the hammer. It weighs about 150 pounds, and it wouldn't raise worth a cent. He put his foot in the loop at the end of the rope, put his whole weight on it and drew it up about a foot, let it drop and went out. The next day he came in and went up to the foreman and said, "That man Bill is the strongest man I ever saw. He can handle that 150-pound hammer like a toy. Ain't he worth a quarter more a day." "Sure thing," said the foreman. "Put in a slip," said the "Old Man," "and I'll pass it." Bill got his quarter raise, but the joke leaked out and it has cost Bill more than the quarter per day to keep the boys quiet about the joke. Bill is afraid that if the "Old Man" gets word of it, his cake will be dough.

* * *

The quality of the alloy steels used for making permanent magnets has been so improved that they are now made of the horseshoe form which will hold suspended ten times their own weight.

FASTENING FOR BANK WINDOW GRATING.

The impression of strength, solidity and safety which every bank and trust company strives to cultivate in the public mind is undoubtedly enhanced by the brave display of heavy bolts, bars, gratings, "unbreakable" vaults, etc., which are a prominent feature of most such concerns. If it were not so there would be less money wasted on them for to the simon pure burglar much of this stuff must seem as vanity. When a trust company takes quarters in a modern office building up go the ponderous gratings over the windows as a matter of course. The accompanying cut shows how the grating of one



How Bank Windows are Guarded.

trust company's offices in New York are secured. While the idea is good as a mechanical expedient it has the obvious fault of being as easily removed as erected. The grating *D* is formed of ten massive bars 2 inches diameter set in four lateral bars, *C*, the two upper ones only being shown. The lateral bars are secured in the wall by the bushings *A* which fit in square pockets drilled into the stone. The enlarged view at the right shows the construction clearly. It is plain, of course, that the bars *C* could be little longer than the width of the window opening but the bushings in effect lengthen them and fix them to the stone walls. When the holes were all drilled a few minutes' work sufficed to set the massive grating and drive the bushings home. And by the same token a few minutes' active work with a hammer and wedge would loosen them.

* * *

PATENT PROTECTION.

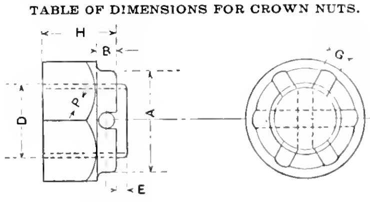
We frequently hear the complaint that patents do not protect or that a patent is about as good as a summons to a lawsuit, etc. The question in effect has been often asked: "Why cannot the present patent condition be remedied so that if an inventor is once granted a patent he will know that he is secure in its enjoyment for its term of life, the same as if he has been granted a lease for a certain tract of real estate, etc." The answer is, of course, that a patent is not intended to be a guarantee of novelty or of prior right under the present interpretation of patent law. It is merely a publication under the seal of the United States that the inventor has devised certain improvements in mechanics or other lines which, so far as the patent office examiners are able to determine, do not conflict with other publications (patents) along the same lines. What the rights of any invention, published in the manner prescribed, are, must necessarily be determined by the courts, for it is outside the natural or possible province of the patent office to determine these rights. That this is only justice and in the natural order of things will be quite obvious to any one who looks at the subject broadly. Take, for example, some device in common use in an industry of unlimited scope or of a sequestered nature. An inventor in another part of the country developing the same industry might invent an identical process, machine or tool, and apply for a patent with no knowledge on his part or of anyone in the patent office of its prior use. Now, after the patent was granted to this inventor, if it were not possible to adjudicate the conflicting rights great injustice might be done to those already using the invention to whom it might be a very old device—known to their forefathers, perhaps. The patent examiner may be regarded as an editor; he sizes up an application for a patent to the best of his ability and compares it with the mass of devices of a similar nature, but with the fullest care in examination there is likely to be a conflict of claims, impossible to avoid. Of course the patent office does decide the conflicting rights of inventors in cases of interference, that is, where two or more inventors ask for a patent on the same idea at the same time, but this is done entirely to determine the matter of relative priority, and in no way affects the standing of the granted patent to the world at large.

* * *

STANDARD CROWN NUTS WITH LOCK.

Of all the nut-locks invented the simple hole through the bolt above the nut with a split cotter has been the most popular on machinery, especially locomotives. It has the defect, however, of not being a positive nut-lock so much as a provision against loss of the nut should it work loose, but the same principle of construction is often used as a positive lock, the hole being drilled through the nut and bolt so that when screwed home the cotter can be put through both and split so as to hold the nut securely in place. This construction is objectionable, however, because it requires the parts to be assembled, marked and afterwards drilled. An improved form is the "crown" nut, of which Mr. A. P. Sharp, Williamsport, Pa., contributes the accompanying table of dimensions, with cut; it is made with the top turned to a smaller diameter and slotted with three grooves across the face. The cut and table are practically self-explanatory and little more need be said. It will be readily understood that, with two holes through the bolt, at right angles, and three slots across the face of the nut, at 60 degrees divergence, a hole and slot must coincide at every one-twelfth revolution. Hence, there can never be any great difficulty in getting a positive locking position and at the same time having the nut tightly screwed home. Of course neatness requires that the holes through the bolt be

TABLE OF DIMENSIONS FOR CROWN NUTS.



H = HEIGHT OF STD. NUT

D & H	B	A	G	E	C	P IN DIA.	LENGTH	DRILL
.5	.15625	.6875	.125	.0625	.15625	.125	.875	.125
.625	.1875	.875	.15625	.0625	.15625	.156	1.25	.15625
.75	.1875	1.	.15625	.0625	.15625	.156	1.25	.15625
.875	.25	1.25	.21875	.0625	.25	.203	1.5	.21875
1.	.25	1.375	.21875	.125	.25	.203	1.75	.21875
1.125	.375	1.5	.25	.125	.375	.25	1.75	.25
1.25	.375	1.75	.25	.125	.375	.25	2.	.25
1.5	.5	2.	.375	.125	.4375	.375	2.5	.375
1.75	.5	2.125	.375	.125	.4375	.375	2.5	.375
2.	.5	2.5	.375	.125	.4375	.375	2.75	.375
2.5	.625	3.	.5	.125	.5	.5	3.5	.5
2.75	.625	3.25	.5	.125	.5	.5	3.75	.5

Machinery, N.Y.

drilled closely approximating the position required when the nut is screwed down but a variation of 1/32 or even 1/16 inch or more, depending on the size, above the ideal position will not affect its action. The crown nut is largely used on agricultural machinery, being usually cast in malleable iron for this purpose. The table, however, applies to standard machine nuts only.

* * *

An aluminum solder patented in England August 3, 1905, is composed of 6 parts tin; 30 parts zinc; 1 part lead; and 1 part aluminum. Resin is used for a flux.

LETTERS UPON PRACTICAL SUBJECTS.

CALCULATIONS INVOLVING THE STOPPING AND STARTING OF LOADS.

Editor MACHINERY:

The accompanying table was compiled to furnish ready data for engineering calculations involving the stopping or starting of live loads and the stresses resulting. It is based on the equation

$$\text{Force} = \frac{\text{weight} \times \text{velocity}^2}{2 \times \text{gravity} \times \text{space}}$$

which is readily derived from the equation for kinetic energy, as follows:

$$E = \tfrac{1}{2} \times \text{mass} \times \text{velocity}^2,$$

where mass = weight ÷ gravity = w/g.

$$\text{Substituting, } E = \frac{w\,v^2}{2g}.$$

Dividing this by s, the space traveled, we get for the force,

$$F = \frac{w\,v^2}{2gs}$$

The quantities in the main part of the table give the fraction of the weight of a body necessary to stop it in the distance shown in the vertical column headed "space traveled." Thus, a body moving 2,000 feet a minute requires a force of 1.736 times the weight of body to stop it in a distance of 10 feet. If it is stopped by sliding friction with a coefficient of 0.174, it will slide 100 feet. At 600 feet a minute a body will move six feet against a force of 0.261 times its own weight. Quantities below the heavy line are for coefficients of friction of less than 0.18, which is the coefficient for iron on steel.

Applications.

(1) Spring Bumpers.—A body weighing 3,000 pounds and moving 300 feet a minute is to be stopped by a helical spring with but six inches compression. The average load on the spring is 3,000 × 0.782 = 2,346 pounds, the initial load being = 0 and the final load = 4,692 pounds.

TABLE GIVING FORCES REQUIRED TO STOP MOVING BODIES.

SPACE TRAVELED	VELOCITIES IN FEET PER MINUTE																	
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1500	2000	2500	3000	4000	5000
0′ 6″	0.087	0.348	0.782	1.390	2.171	3.125	4.25	5.65	7.35	8.68	10.50	12.50	19.54	34.74	54.25	78.20	139.0	217.1
1′ 0″	0.0434	0.174	0.391	0.695	1.085	1.563	2.125	2.772	3.53	4.34	5.26	6.25	9.77	17.36	27.12	39.10	69.5	108.6
2′ 0″	0.022	0.087	0.195	0.348	0.543	0.782	1.063	1.385	1,758	2.17	2.625	3.125	4.885	8.68	13.55	19.53	34.75	54.3
3′ 0″	0.014	0.058	0.130	0.232	0.363	0.521	0.785	0.925	1.172	1.445	1.750	2.082	3.255	5.79	9.40	13.02	23.17	36.21
4′ 0″	0.010	0.043	0.098	0.174	0.273	0.391	0.531	0.694	0.880	1.085	1.312	1.573	2.442	4.34	6.78	9.77	17.36	27.15
5′ 0″	0.009	0.035	0.078	0.139	0.217	0.313	0.425	0.555	0.704	0.868	1.050	1.250	1.954	3.475	5.43	7.82	13.89	21.75
6′ 0″	0.007	0.029	0.065	0.116	0.181	0.261	0.354	0.463	0.586	0.724	0.876	1.042	1.628	2.895	4.52	6.52	11.57	18.10
7′ 0″	0.006	0.025	0.056	0.099	0.155	0.223	0.304	0.397	0.503	0.621	0.750	0.893	1.395	2.480	3.875	5.58	9.93	15.53
8′ 0″	0.0054	0.022	0.049	0.087	0.136	0.195	0.266	0.347	0.440	0.543	0.657	0.782	1.222	2.171	3.380	4.89	8.68	13.58
9′ 0″	0.0048	0.019	0.043	0.077	0.121	0.174	0.236	0.309	0.391	0.483	0.584	0.695	1.085	1.930	3.013	4.34	7.72	12.07
10′ 0″	0.0043	0.0174	0.039	0.069	0.109	0.156	0.213	0.277	0.354	0.435	0.525	0.625	0.977	1.736	2.712	3.92	6.94	10.86
25′ 0″	0.0017	0.007	0.0156	0.0278	0.0434	0.0625	0.085	0.111	0.145	0.174	0.210	0.250	0.391	0.695	1.085	1.563	2.78	4.35
50′ 0″	0.0009	0.0035	0.0078	0.0139	0.0217	0.0315	0.0435	0.0555	0.0704	0.087	0.105	0.125	0.195	0.348	0.543	0.782	1.39	2.175
100′ 0″	0.0004	0.0017	0.0040	0.0070	0.0108	0.0156	0.0213	0.0277	0.0352	0.043	0.053	0.063	0.098	0.174	0.271	0.392	0.695	1.086
500′ 0″	0.0001	0.00035	0.0008	0.0014	0.0022	0.0032	0.0044	0.0056	0.0070	0.0087	0.0105	0.0125	0.0195	0.0348	0.054	0.078	0.139	0.2175

Machinery,N.Y.

(2) End Thrust on Cranes due to Stopping or Starting a Trolley with Load.—(This is used in the calculation for bending or runway girders, the bending on columns, and the stability and side bracing for gantry cranes.) A 20,000-pound trolley and load moving 500 feet a minute stops in a distance of six feet. The end thrust produced is 0.181 × 20,000 = 3,620 pounds. If stopped in two feet the force would be 0.543 × 20,000 = 10,860 pounds.

In the same way the table gives the lateral forces producing bending on the crane girders, due to stopping and starting. The force required to stop the girders is uniformly distributed, while for the live load it is concentrated.

(3). A body weighing 1,200 pounds is given a velocity of 800 feet a minute while traveling nine feet. The force required is 1,200 × 0.309 = 367.2 pounds.

(4). A car moving at 1,500 feet a minute (about 17 miles an hour) will slide 50 feet with wheels locked if coefficient of friction is 0.195. To stop it in 25 feet by using sand on the rails, the coefficient must be raised to 0.391 feet.

(5). The time elapsed in (4), without sand, is 50 ÷ 750 minutes = 4 seconds. With sand the time would be 2 seconds.

Cleveland, O. L. H. MILLER.

LINING CONNECTING RODS.

J. V. N. Cheney.

Editor MACHINERY:

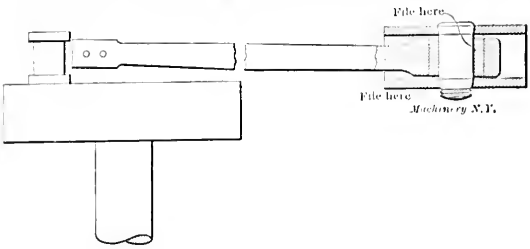
It frequently happens that proper care is not exercised in fitting up connecting rods in the shop to get them in line, or one might say to get them to "point" right. Owing to the brasses not being bored out at right angles to the rod, when they are put on the pins, they will naturally bind, with the result that they run hot and pound. The writer has had considerable experience in this line, and has found many examples of this bad practice, both on locomotive and stationary engines. For example, the wrist-pin brasses of a 36 x 60-inch engine could not be made to run cool; it was, of course, due to lack of care on the part of the erector, to see that both ends of the rod pointed right before putting it up for good. In this case it was necessary to remove the wrist-pin weighing about 125 pounds—a task of no small proportions and away from the shop, where tools were scarce. Fortunately, there was a good sized bolt hole tapped into the inside end, so by a combination of bolt, strap and heavy sledge hammer, the pin was started loose. The sketch shows, exaggerated, the position the rod was in when disconnected from the crank-pin. To make it point right the brasses were filed, and scraped at the points indicated, a matter requiring several trials before the proper pointing was attained.

Sometimes it happens that the crank, or disk, is not true with the shaft, or the pin is out of square with the crank.

J. V. N. CHENEY was born in Bradford, Vt., 1857. He commenced work on machinery in Colt's Armory, Hartford, at the age of 14, and has continued in that line of work up to the present time. His term of apprenticeship was served with the N. Y., N. H. & H. R. R., at Hartford, Conn.; he has since been employed by the N. Y. & N. E. R. R.; Illinois Central; South Side "L," Chicago; Masonic Temple, Chicago; G. J. Railway and U. S. Government. His positions have been those of locomotive engineer, locomotive foreman, chief engineer, round house foreman and erecting engineer.

In these cases pointing of the rod is even more important than where they are true with one another. The writer attributes his success with rods to this feature, though it is a good practice to be careful that the fillets are entirely clear, as their wearing will cause the brasses to heat and give trouble.

It frequently happens that the bushings in a solid ended rod are worn, but not enough to warrant throwing them away,



Lining Connecting-rods.

and are allowed to run longer than they otherwise would. A cheap and convenient way to repair these bushings, is to remove them from the rod; then, with a thin cutter, or if a milling machine is not available, a cutting-off tool in the shaper, a slot is cut through the bushing to allow it to close. With a thin iron liner of the proper thickness, press the bushing again into the rod, pin if necessary, and bore out to size required. The writer has seen many rods repaired in this manner, doing as well as with new bushings. J. V. N CHENEY.

South Portland, Me.

COPPER CHUCKING STRIPS FOR LATHE CHUCKS.

Editor MACHINERY:

I frequently have a number of duplicate pieces finished on one side and outside and inside diameters to finish on the other face. In place of using loose strips of copper or brass between the chuck jaws and the finished surface, I take strips of copper or brass about 4 inches long and from 1/4 to 1/2 inch wide, according to the distance the work acts back in the jaws, so that the copper will not extend quite as far back as the work. I bend these strips so as to fit closely around the outside step of the jaw. I have two or three sets of different widths for different kinds of work. They last a long time and remain in place while changing from one piece to another. Beside the amount of time they save in putting loose strips in place for each piece of work, they save an immense amount of time in chucking, as they fit themselves to the grooves in the jaws and after the first piece is accurately centered the duplicates will need only a slight change of pressure on the two marked jaws to bring them to center.

I have a number of rings of different diameters accurately faced, one of which I place behind any piece that will not set back against the faceplate of the chuck and tap the piece back against this to true it up after I bring it to center. By having the strips of copper narrow there is no shoulder to prevent the work from tapping back solidly against the ring.

Schenectady, N. Y. ROBERT MAYHEW.

THE LATHE AS A SPECIAL MACHINE.

Joseph M. Menegus.

Editor MACHINERY:

A large number of machines have been invented to meet the requirements of modern machine shop practice for the rapid production of interchangeable pieces; and, for the most part, they are good machines which do just what is claimed for them. Years ago, when one of these machines was installed in a machine shop, it was a source of curiosity and comment. Men would stop to look at it with interest and the boys would look at the man who ran it with contempt, for he could produce, perhaps, five times as much work as he would do on the old lathe. To-day whole departments are equipped with one type of these special machines, and they are coming more and more into favor, for they are indeed wonderful dividend producers. But these machines cost

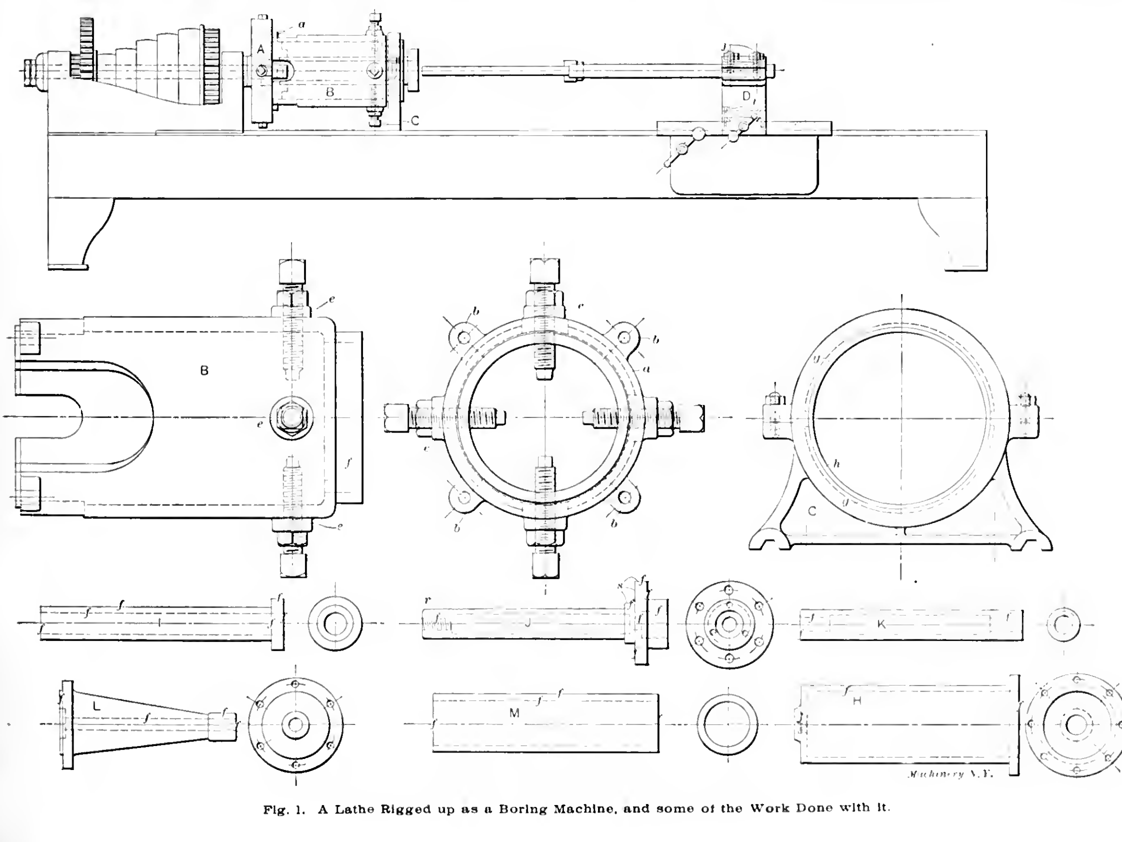


Fig. 1. A Lathe Rigged up as a Boring Machine, and some of the Work Done with it.

piles of money, and if the large manufacturing concerns with almost unlimited capital can afford to buy them, small and medium-sized shops often cannot. Furthermore, a small shop may not have enough work to keep the machine going, and in this case it is a bad investment. One of the principal aims of a successful foreman of one of these shops should be to specialize his machines as far as possible, and do this economically, which is not an easy task by any means.

The accompanying cuts show a lathe transferred into a special machine and some of the tools and attachments. The lathe should be strongly built and should have a hollow spindle; if it has a solid spindle it should be bored out, but if it will not stand boring a heavier spindle should be made, and the cone pulley, gears and bearings rebored to suit the new spindle. A universal chuck, *A*, is provided, which is bored to receive bushings to guide the boring bars. The casting *B*, which I call a supplementary chuck, has a ring attachment, *a*, which fits on the left end of *B*, and is provided with four lugs, *b*. These are used to bolt *B* onto the chuck *A*. Piece *B* has four openings, three of which are only large enough to allow the carriage by means of the bolts *i* and is bored in place to the same size as the boring-bars. The holder is split on one side and is provided with a feather; the bars are tightened in place by means of the screws *j*. *F*, Fig. 2, shows the kind of boring bars used. The part *m* fits the bushing in *A*; and *n*, the bar-holder *D*. The feather ways *o* are for the feather in the bar-holder. A number of boring tools, for boring the smaller holes, are made as shown at *p*. For facing surfaces of small diameter grooved tools as shown at *G* can be used for roughing and similar tools without grooves for finishing. The tool-holder *H* is for boring holes of larger diameter. It is made of cast steel and can hold either boring or facing tools. Several of these tool-holders are made so as not to disturb the tools when they are set for a certain job, and are to be used again in the near future. A number of reamers can be made as shown at *O*, and taps can be constructed in the same way, where the tapping has to be done.

H, *I*, *J*, *K*, *L* and *M*, Fig. 1, show some of the pieces that can be successfully machined on the special lathe; the marks *f* denote finishing. Pieces *J* and *H* require tapping. Piece *J*,

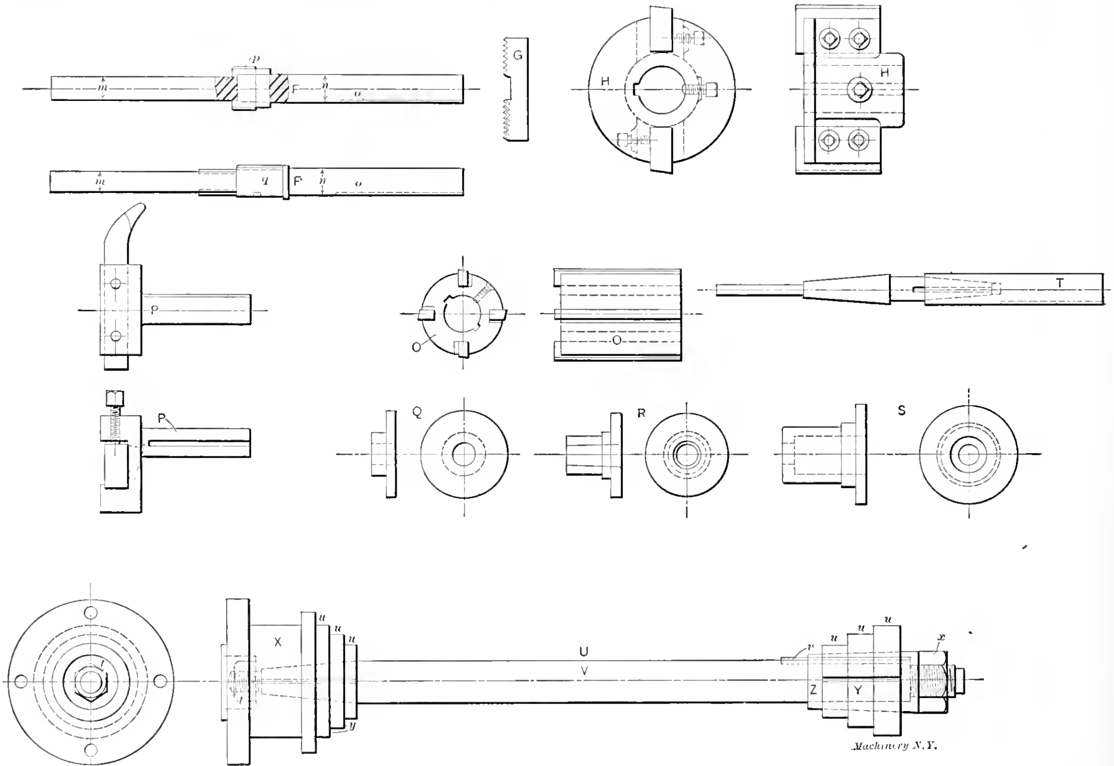


Fig. 2. Tools used in a Specially Equipped Boring Lathe.

the jaws to pass and one is larger in order to allow the hands of the operator to pass in. The four bosses, *e*, are each tapped for a tempered steel screw that has a lock-nut to prevent it from turning after the piece to be bored has been centered. The part *f* is carefully turned and on this part is fitted a special steadyrest, *C*, whose construction can be readily seen in the sketch. It is made of cast iron, in two pieces, fitted and bolted together and cast with receptacles, *g*, to hold babbitt or other anti-friction metal. The steadyrest is put on the machine and the babbitt metal bored in place to the same diameter as *f* of piece *B*.

The cross-slide is removed from the old lathe, and the boring bar-holder *D* put in its place. This holder is bolted on which is a stuffing-box and valve stem nut, can be machined at one operation. It is chucked at *r* and after it has been bored, tapped and faced, it is turned and faced at *s*. To do this the screws *i* have to be removed, and the bar-holder *D* used as a cross carriage, using the tool-holder *P*, which fits the bar-holder *D*. Piece *L* also requires the use of this tool-holder to face and turn down its fitting. If there is not enough work of this kind to keep these machines and tools busy, the machine can be used for boring and facing short pieces, as shown at *Q*, *R* and *S*, removing piece *B* but using the same bars, tools and tool-holders with the addition of bar *T*, which is bored to receive taper reamers and taps, these being guided by the same bushing as the boring-bars.

For turning linings *M* or sleeves *I* on the outside a mandrel, as shown at *U*, is very useful. The steel bar *V* is tapered at one end to fit the piece *X*, which latter is fitted and bolted on a faceplate, and is counterbored for the nut *t*. Piece *X* is turned off at the steps *u* to the same diameter as the bore of the linings. The expansion ring *Y* is also turned of the same diameter as the bore of the linings, and is bored tapering.

Joseph M. Menegus was born in Venice, 1873. As a boy he served a term of apprenticeship with his father in Venice, and five years ago he finished a course of mechanical engineering with the International Correspondence Schools of Scranton. He has been employed by W. G. Armstrong & Co., Mitchell & Co., F. Mondini & Co., H. R. Worthington Hydraulic Works, C. D. Mosher (naval architect), Lidgerwood Manufacturing Co., etc. His positions have been those of machinist in all the different branches of the trade, general foreman, draughtsman and constructing engineer; he has lately been associated with two inventors, developing their ideas, and designing new devices and machinery, the construction of which he will superintend.

The taper piece z fits the bar V closely and is guided by means of a feather, v; it expands ring y when the nut x is tightened. The finished faces of the linings go against the steps of the piece x. The linings are driven against the pressure of the cut by the feather v and by friction against the faces of X and Y.

These are only a few of the pieces that can be machined and a few of the tools that can be used. A larger variety of tools can be made to meet different requirements.

Los Angeles, Cal. J. M. MENEGUS.

METHOD OF FINDING PITCH ANGLE OF BEVEL GEARS.

Editor MACHINERY:

Recently I had to find the angle of pitch for a pair of bevel gears and as it cost me some time to figure them, I think the method will be of some interest to the readers of MACHINERY.

One of our customers sent us a pair of bevel gear patterns as per sketch, with 40 and 16 teeth, and an angle of shaft of

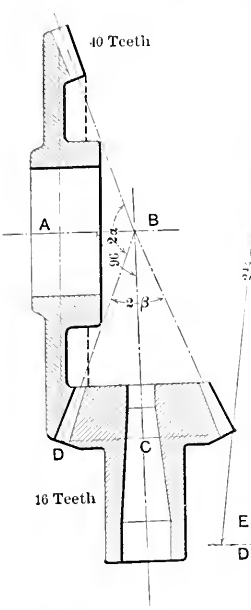


Fig. 1. The Gear the Customer Ordered.

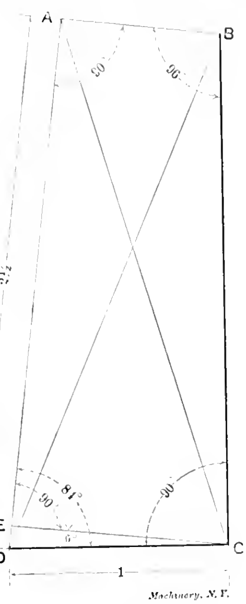


Fig. 2. Diagram showing Solution of Problem.

96 degrees without any other terms, and wanted to have same manufactured on the so-called Warren gear cutter. I found the pitch angle as follows:

A quadrilateral, Fig. 2, was drawn having two adjacent sides in the proportion of 1 to $2\frac{1}{2}$ (the same as the gears) and in which the opposite angles $D\,A\,B$ and $D\,C\,B$ are right angles, these angles corresponding to those indicated by the same letters in Fig. 1. Now, it will be observed that the diagonal $D\,B$ is a side common to both right triangles $D\,A\,B$ and $D\,C\,B$. Hence a circle, having its center on the line $D\,B$, can be circumscribed around the quadrilateral which will pass through the vertices of the four angles D, A, B and C. With this construction it is apparent that angle $A\,C\,D = A\,B\,D = \alpha$, or one-half the included pitch angle of the larger gear.

$$\cos 6^\circ = \frac{E\,C}{1};\quad E\,C = \cos 6 = 0.994522$$

$$\sin 6 = \frac{D\,E}{1};\quad D\,E = \sin 6 = 0.104529$$

$$\tan A\,C\,E = \frac{A\,E}{E\,C} = \frac{A\,D - D\,E}{E\,C} = \frac{2.5 - 0.104529}{0.994522} = \frac{2.395471}{0.994522} = 2.4087$$

Angle $A\,C\,E = 67^\circ\ 27'$.

Angle $A\,C\,E + E\,C\,D = A\,C\,D = A\,B\,D = \alpha = 67^\circ\ 27' + 6^\circ = 73^\circ\ 27'$.

Angle $D\,B\,C = \beta = 96^\circ - \alpha = 96^\circ - 73^\circ\ 27' = 22^\circ\ 33'$.

Angle of pitch of 40 teeth gear $= 2\,\alpha = 146^\circ\ 54'$.

Angle of pitch of 16 teeth $= 2\,\beta = 45^\circ\ 6'$.

It would be simpler but not so exact to use the graphic method. Draw angle $ADC = 180^\circ - 96^\circ = 84^\circ$ with the use of a Brown & Sharpe protracter; make $DA = 2\frac{1}{2}\ DC$ and erect in A and C perpendiculars which meet together in point B; now connect B with D. The angles thus found, $ABD \times 2$, is the pitch angle of the 40-tooth gear and $DBC \times 2$ is the pitch angle of the 16-tooth gear. OTTO ECKELT.

Berlin, Germany.

[It is possible to obtain a simpler general expression of Mr. Eckelt's solution of the bevel gear problem. For, since $E\,C = D\,C \times \cos E\,C\,D$ and $D\,E = D\,C \times \sin E\,C\,D$, the following equation will be true:

$$\tan A\,C\,E = \frac{A\,D - D\,E}{E\,C} = \frac{A\,D - (D\,C \times \sin E\,C\,D)}{D\,C \times \cos E\,C\,D}$$

$$= \frac{A\,D}{D\,C \times \cos E\,C\,D} - \frac{D\,C \times \sin E\,C\,D}{D\,C \times \cos E\,C\,D}$$

If N = the number of teeth in the large gear, and n the number of teeth in the small gear, then will $\frac{N}{n} = \frac{A\,D}{D\,C}$; also we know that $\frac{\sin E\,C\,D}{\cos E\,C\,D} = \tan E\,C\,D$. Substituting these expressions in the above equation, we have

$$\tan A\,C\,E = \frac{N}{n \times \cos E\,C\,D} - \tan E\,C\,D.$$

$$\alpha = A\,C\,E + E\,C\,D$$

This makes a very convenient method of finding the pitch cone angle of two bevel gears, but it is scarcely any easier than using the formulas given in the Brown & Sharpe "Formulas in Gearing," or those given by Mr. Porter in the September (1905) issue of MACHINERY. Mr. Eckelt's way of approaching the problem is, however, new, so far as we are aware.—EDITOR.]

DRAW-IN CHUCK FOR ENGINE LATHES.

Editor MACHINERY:

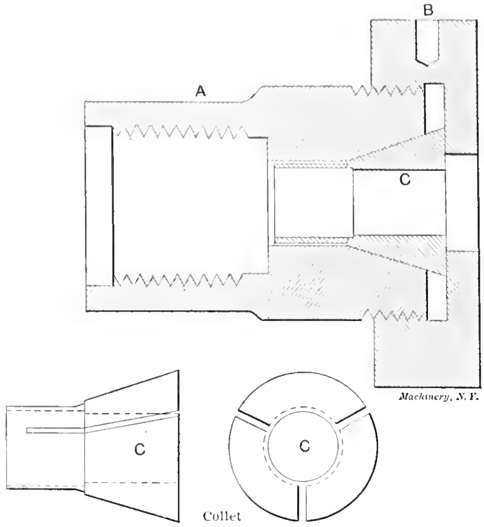
C. J. Shaw.

The sketch shows a special chuck of the draw-in style which can be fitted to any lathe spindle, or can be made to fit a milling machine spindle. This chuck is used for round stock of $\frac{1}{4}$ to $\frac{3}{4}$ inch diameter, or the range can be made even greater by making bushings or collets to take larger stock. Cold rolled stock threaded to make studs can be held firmly and will run true on account of the tapered bushing centering itself when drawn in place by the binding collar. An advantage over the usual three or four-jawed chuck is, that when a piece of standard sized cold rolled stock or drill rod is to be threaded, or turned so as to leave a part of the original size on the finished piece, the 3- or 4-jawed chuck is sure to mar the piece more or less and time has to be taken also to adjust the jaws to get the stock to running true; with the chuck shown in the sketch there is no marring of the stock and no time taken in getting the piece to be machined to run true.

The sketch shows but one collet, but of course there has to be one for each size of stock used. The bushings should be case-hardened if made of soft steel or hardened and drawn if made of cast steel. After hardening they should be ground inside and the tapered part outside.

C. J. SHAW was born in Rochester, N. Y., 1878. In addition to a common school education, he studied mechanical drawing in an evening school and is now taking a course in mechanical engineering with the International Correspondence School. He served an apprenticeship with the W. P. Davis Machine Co., Rochester, N. Y., and has since worked for the Cadillac Motor Car Co., holding positions of machinist and tool-maker. His especial interest is experimental work and tool making.

Part *A* is fitted to the lathe spindle on one end and is bored taper to receive the split bushings and threaded for the binding collar, on the other end. Part *B* is the binding collar, which, when screwed up against the bushing *C* compresses *C* and binds the work. Part *B* should be made of soft steel and



A Draw-in Chuck for the Engine Lathe.

case-hardened. A hole is drilled in the periphery to receive the nipple of a spanner wrench for tightening and loosening *B*.

Part *C* is the split, hardened and ground bushing. If thought advisable a key can be fastened in the clearance space in *A* and a slot milled in the bushings to fit the key to keep the bushings from turning when being either tightened or loosened.

When the saw cuts are made in the bushings to allow for compression, the saw should not quite cut clear through at the front end, but a little metal should be left in the cut to keep the parts from springing too much when hardening. After hardening, the metal left in the cut can be removed by grinding with a thin emery wheel or by striking on a thin drift which will go in the saw cut. C. J. SHAW.

Detroit, Mich.

The benzine will evaporate very quickly and leave the original in as good a condition as before print was taken. Care should be taken that too much benzine is not used as it might spot the original if blueprint solution were to be reached by any great quantity of benzine, although I have never experienced this difficulty even though I have made many prints by this method. R. F. KIEFER.

Sharon, Pa.

TO REMOVE INK LINES FROM TRACINGS.

Editor MACHINERY:

The writer has tried numerous methods for erasing ink lines from tracings, with the best results as follows: Place the part of the tracing, containing line to be erased, upon some hard substance, such as celluloid triangle, and run over it lightly with a razor edged knife; this leaves the cloth in sort of a rough condition, which will readily be taken hold of by a medium hard eraser. The tracing may then be smoothed down by using the rounded edge of the knife handle or its equivalent, and will then take the ink without causing the latter to run. CALVIN B. ROSS.

Springfield, Ohio.

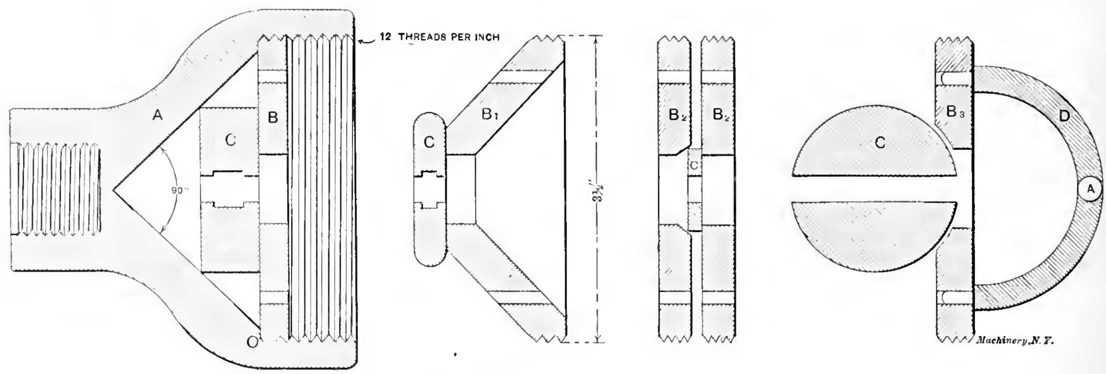
SELF-CENTERING CHUCK.

Editor MACHINERY:

L. E. Muncy.

I show herewith a sketch of a *real* self-centering chuck, which I made several years ago, and which may be of use to the readers of MACHINERY. I designed this originally for holding milling cutters after tempering, to grind the hole to size, but having it fitted to a 14-inch lathe on which I did my cutter grinding, I found it very handy many times on odd pieces which were required to be chucked very accurately. The chuck body *A* and follower plates *B* were made from cast iron, which with the spanner wrench *B* completed the outfit. Plate *B* could be reversed if necessary, shoulder *O* being faced true. Two plates, as B_2B_2 were used to bore out a thin washer to size. The plate shown at B_3 is used for boring a hole through the center of a ball, etc.

Syracuse, N. Y. L. E. MUNCY.



A Self-centering Chuck for the Engine Lathe.

TO MAKE BLUEPRINTS FROM BRISTOL BOARD ORIGINALS.

Editor MACHINERY:

Oftentimes a draftsman finds it advisable to make blueprints of cuts and drawings of which he may have a copy on Bristol-board, heavy drawing paper, etc. This is a long and tedious operation if conducted in the usual manner, but if the sheet to be printed is first given an application, or "coat," of gasoline or benzine, on the face side, then printed, the result will be better and more quickly obtained than by the ordinary way.

CHEAP SUCTION AND LEAD HOSE.

Editor MACHINERY:

Where hose is needed only for suction purposes or for leading liquid away where there is little pressure, as in pumping

L. E. MUNCY was born in the town of Cuyler, Cortland Co., N. Y., 1858. He served a term of apprenticeship with Cooper Bros., of Cortland, N. Y. He has worked for the Porter Manufacturing Co., Syracuse, N. Y., Rowley & Hermance, Williamsport, Pa.; C. E. Lipe, Syracuse, N. Y.; Orange County Foundry Co., Middletown, N. Y., and several others, in the various capacities of all-round shop workman, shafting turner, toolmaker, planer hand, lathe hand, floor hand, machine tool assembling shop foreman, etc. For the last five years his work has been the making of steel molds for "finishing castings" for the H. H. Franklin Mfg. Co., Syracuse, N. Y.

out bridge caissons, draining mines, etc., it is not worth while to pay for regular made two-ply seamless rubber hose, which, moreover, can only be made in short sections, because of the great cost and weight of the mandrels on which such hose must be made and vulcanized. The cheapest way is to sew up canvas duck on a Blake or similar sewing machine (two seams), and then, having wound galvanized steel wire on a mandrel of a diameter a very trifle greater than the internal diameter of the hose, to spring this in the latter, being sure to make the ends of the spiral fast to the couplings. The purpose of the spiral inlay is to keep the hose sprung out to the full diameter, and to prevent kinks. Where there is danger of excessive wear by dragging on the ground, the hose may be reinforced by an outer spiral or by a canvas jacket, although it will usually suffice to give only those points that are most subject to wear, such protection. When once this hose gets wet it is tight against the atmospheric pressure from without, and up to about two atmospheres (30 pounds per square inch) from within—always provided in the latter case, that the canvas will stand the bursting stress. Where there is much such stuff to make, it is better to order canvas in which the woof or filling is stronger than the warp, as the cross threads get the principal stress. If the canvas be tanned it will last longer. Such hose, without the inner spiral, is very much used for tank hose at railway watering points. When a tramp happens to cut a hole therein for the purpose of getting a drink, the loss is not so great as when this occurs with regular mandrel-made vulcanized rubber hose. The cost for such tank hose is about one-fifth that of the two-ply rubber.

Hanover, Germany. ROBERT GRIMSHAW.

PATCHING TIRES—A REMINDER OF THE DAYS OF THE THE WROUGHT IRON LOCOMOTIVE TIRE.

Editor MACHINERY:

The illustrations show a hard and what was always a rush job on roundhouse work during the era of wrought iron locomotive tires. A great deal of trouble was caused by flat spots developing in the tread of the tire, and to turn these spots out was not to be thought of unless the engine was in for general repairs. Under the circumstances it was a clear case

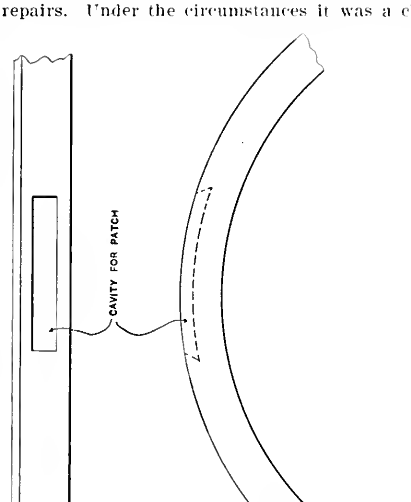


Fig. 1. Fig. 2.
Patching Wrought Iron Locomotive Tires.

of patching the tire. These low spots would sometimes be all of twelve inches long by about two inches wide. To make a seat for the patch we would in most cases use a ratchet and "tit" drill the width of the depression. The use of the drill saved us a great deal of chipping; the chipping was a hard job from the fact that in almost every case the job stood right up and down before us, there being no room to work by turning the wheel so as to bring the work on top. After drilling we would chip the cavity to the shape shown in Fig. 1 and dovetail the ends and sides as indicated in Fig. 2. The blacksmith would then forge a patch just a little longer and as wide as the cavity, and of a thickness to fill up in good shape. There was a chance here for the blacksmith to show some good judgment. When the patch was forged all right he would give it a bend endwise, making it shorter than the cavity. The patch was then heated a bright cherry red, brought to the job, put in and hammered vigorously into place with the ball pene of the hammer so as to force the patch under the dovetail along the edge. The tire having a tendency to cool the patch it took lively work as the cooling had to be followed up with the hammer to head off shrinkage. When it was in good and solid we chipped off the surplus to a template. Was it hard work? Yes; and it was always a stay-till-you-get-it-finished-job and it run well into the night too. Then it was put up wheel covers, couple up the tender, etc., but I was young then. W. DE SANNO.

Soldiers' Home, Cal.

AUTOMATIC TURRET WORK.

Paul W. Abbott.

Editor MACHINERY:

The accompanying sketches show a set of tools for making the piece shown in Fig. 1 in the automatic turret lathe. These pieces were to be made of cast iron finished all over, accuracy limit 1-64 inch, but it was necessary that the outside run dead true with the hole. The finish on the work had to be such that they would take a good polish without any filing or hand tooling.

Fig. 2 shows the casting of which this piece was made. The castings were made so that there would be plenty cf stock to come off, for it is much more economical on work requiring a good finish to take off a generous amount of stock than to try and work just under this scale.

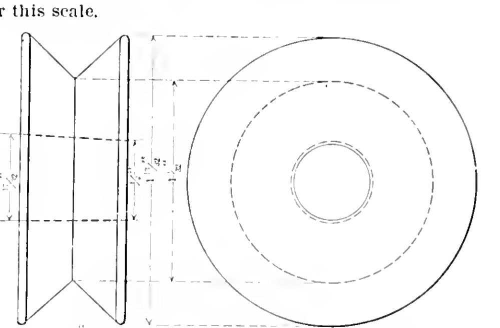


Fig. 1. Piece to be Made on the Turret Lathe.

The automatic was equipped with a three-jawed lever chuck made to take false jaws, and as we had never done any small work on this automatic it was necessary to make new jaws. Fig. 3 shows a duplicate of the slides on the chuck onto which

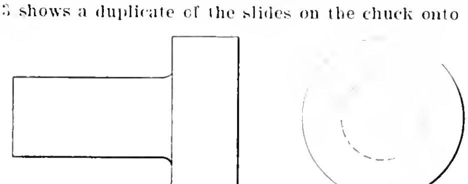


Fig. 2. The Casting from which Fig. 1 is Made.

the jaws bolt. This was used as a template, all the work on the jaws and boring fixtures being laid off from this template. The line *A* scribed on the template represented the center line

PAUL W. ABBOTT was born in Lowell, Mass., 1884. His education outside of the common school has been derived chiefly from home study and evening schools. He commenced work at the age of 14 in the Lowell Machine Shop and has remained there ever since, working his way up to his present position of toolmaker. His specialty is automatic turret tool-making and grinding.

of the chuck. The shoulder, C, locates the jaw on the chuck.

Fig. 4 is the boring fixture, being a false plate made to bolt onto one of the lathe faceplates. The dimension B_1 is the same as B on template. So with the holes laid off the same, it followed that the jaws drilled from the template and transferred to the boring fixture to be bored, and then to the chuck, ran practically true.

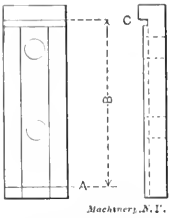


Fig. 3. Template for Machining False Jaw.

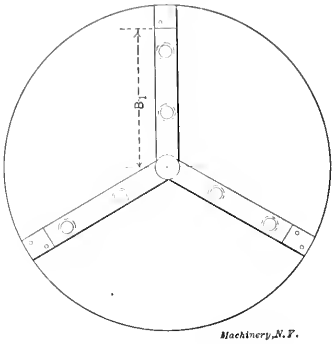


Fig. 4. The Chuck used.

The operations on the work are as follows:

First, turn over top and drill with combination tool held in turret, Fig. 5.

Second, form groove with circular forming tool held on the holder, Fig. 6, on back block on cross-slide. The forming tool was 2½ inches diameter and was bolted to the holder with a 1-inch bolt tightened with a 14-inch wrench. No trouble was experienced with tools slipping.

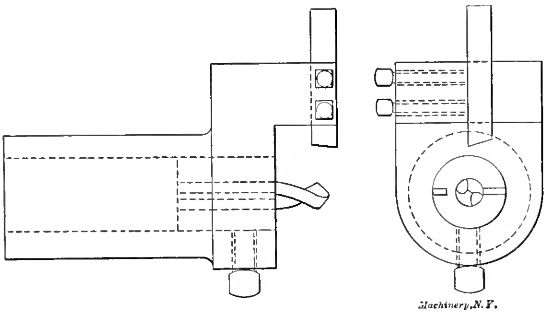


Fig. 5. Tool for Turning and Drilling.

Third, while the forming tool was cutting, the boring tool was advancing, starting to bore the instant forming tool had stopped cutting. Not being satisfied with anything in the line of an adjustable boring tool holder that I had seen, I designed the one shown in Fig. 7. The range of adjustment is wide and can be readily understood from the sketch. The boring

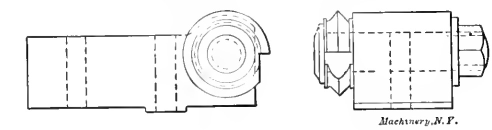


Fig. 6. Form Tool for Turning the Groove.

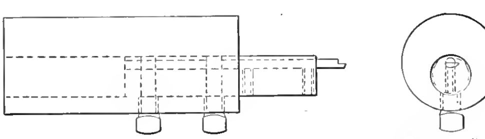


Fig. 7. Adjustable Boring Tool.

tool was made from ¼-inch drill rod, although larger stock could be used just as well with this same idea. This holder is not a costly one to make and fills the bill for easy adjustment and stiffness.

Fourth, squaring both sides and reaming. The squaring tools were in the front block, Fig. 8 on the cross-slide. The reamer was held in a floating holder in the turret. The reamer reams to depth and then stops; the squaring tools are cutting meanwhile. When the tools cut through to the hole the work stays on the reamer and the squaring tools back off. The reamer also backs off, carrying the piece on it. The opera-

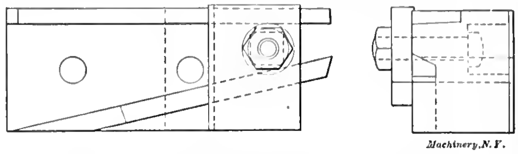


Fig. 8. Tool for Squaring the Sides and Cutting Off.

tor removes shank of casting from chuck, puts in another casting, starts turret in and removes finished piece from reamer, thus completing operation.

This set of tools was a complete success in every way. Time for one piece, 4½ minutes, 125 per day.

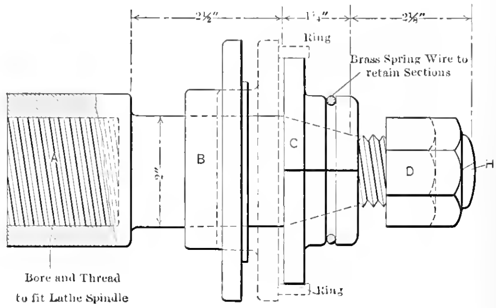
Lowell, Mass. PAUL W. ABBOTT.

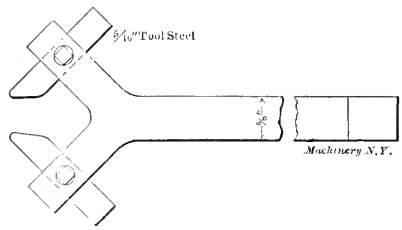
* * *

RING TURNING AND FACING FIXTURE.

Editor MACHINERY:

The cut shows a ring turning or facing fixture which I have found very useful. The device is a mandrel bored and threaded at one end to fit any lathe spindle desired; the mandrel is turned down for the sliding collar B which is used only for locating the ring squarely in position. The end of the mandrel is turned tapering and is threaded with 1¼ inch standard thread for the nut D. On the taper part is fitted the expanding part C which is a collar cut into three sections. These sections are held together by a brass spring wire fitted in a groove turned on the collar. Various sizes of these collars are made, one for each size of ring to be turned.





Ring Turning Fixture and Facing Tool.

To operate the device we first screw it onto the lathe spindle, and slide collar B up against C, then tighten up the nut D with the ring to be faced, in place butted against B. Then B is slid back out of the way. The dotted lines indicate the positions occupied by the ring and the collar B when setting the ring.

The lathe tool shown is used for facing, every ring being faced to exactly the same width and with parallel faces. It will be observed that the flange of C on which the ring is mounted is narrower than the ring in order to clear the lathe tools and that a boss is provided on B so that in setting the ring it will overhang slightly on that side.

GEO. W. SMITH, JR.

Marquette, Mich.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

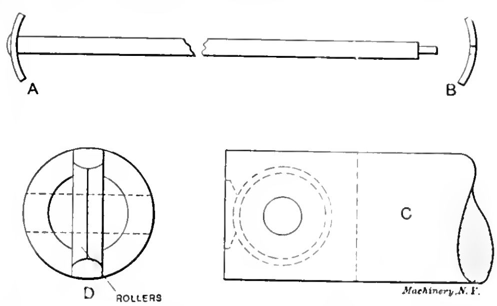
TO REMOVE BROKEN TAPS FROM BRASS OR COPPER.

To remove broken drills, etc., from brass or copper in which they have been broken off immerse the piece in a strong solution of alum for a few days, or until the steel is sufficiently rusted away to be easily removed with pliers or tweezers. I have tested this scheme and have found that a tap or drill broken off in brass will all turn to rust in time if immersed in alum solution as directed. The alum seems to attack every exposed portion of the steel and eats clear to the center, leaving nothing but rust in the hole. Re-tapping or re-drilling can then be accomplished and the piece saved. In many cases, of course, the tap or drill can be removed after the process has been going on for a short time, but how long depends upon the size of the hole and nature of the break in the tap.

Dayton, Ohio. V. H. Marcellus.

RIVETING IN THE TURRET LATHE.

There was occasion to make something like 180,000 pieces like sketch, of No. 12 brass wire about $5\frac{1}{2}$ inches long. The wire came to us cut in lengths so the ends had only to be shouldered in the turret lathe. The heads or washers (shown at *B*) of No. 16 sheet brass were stamped out to shape in a press in the usual way. We then made a holder as shown at *C* which was simply a 1-inch round piece of steel with a slot ¼ inch wide in which were held two rollers together on a 5/16-inch pin, making a concave the shape of rivet head



wanted. This holder was held in the head of lathe; *D* is the end view of *C*. A is the finished end of wire and *B* is end to be riveted. The riveting is done by sticking the heads or washers on the wire, the wire being held in a chuck in the turret; it is then brought up to the rollers with some pressure which spins the end of wire better and faster than it was formerly done with a hammer. After one head is spun on, the wire is caught in another chuck and the process repeated.

Moline, Ill. Albert D. Knauel.

TO CUT INDIA RUBBER.

Those who have had to cut heavy gaskets have found india rubber an unpleasant material to work. The cut can be made sweet and clean if the knife be kept wet; and if conditions permit, this can be best effected by doing the cutting under water, as good housewives know how to do when peeling onions. Potash water is better than plain.

Hanover, Germany. Robert Grimshaw.

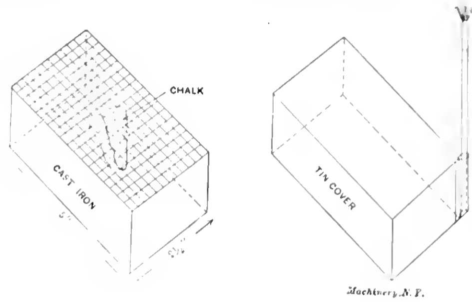
TO MAKE IRON OR STEEL RUST-PROOF.

To make iron or steel pieces rust-proof and at the same time give them a nice finish, heat the article to a dark red and dip it into raw linseed oil; hold it there for a few seconds, then withdraw, let it cool and wipe dry. This treatment will make a permanent and glossy finish. F. Pavlik, Jr.

Winnetka, Ill.

BUILDERS' CHALK EOR SCRAPING AND FITTING.

One thing worth knowing when scraping two surfaces together is that unprepared red builders' chalk is far better and cleaner to handle than the red and blue paints commonly used. Rub the chalk on a cast-iron block grooved lengthwise and crosswise with a pointed tool so the grooves are about 1-32 inch deep and ¼ inch apart. Put on a few drops of machine oil, thus forming a red paint. Considerable rubbing is necessary to bring out the bright red color. This paint



does not have the sticky, gummy nature of the usual red or blue paint. The sketch shows my rubbing block and its tin cover. This cover has a brush holder soldered to one corner so that the brush need never be laid upon the bench to collect dust and dirt. A. L. Monrad.

New Haven, Conn.

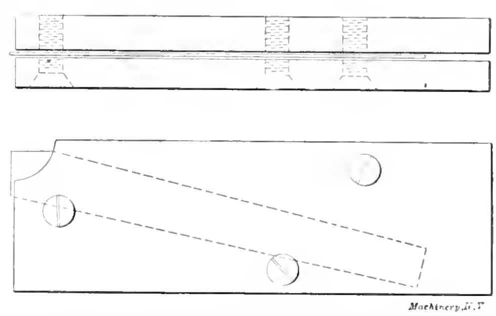
TO PREPARE A SHAFT FOR BABBITTING.

In answer to one of Mr. H. E. Wood's "Don'ts" in the January issue of Machinery in regard to wrapping a piece of paper around a shaft when casting babbitt bearing, I would suggest that the next time he has occasion to cast such a bearing, instead of using paper he use a torch with which to smoke the surface of the shaft to be babbitted. I think he will find this far ahead of the scheme he suggests.

Tallmans, N. Y. V. Smith.

CUT-OFF TOOL FOR THIN BRASS TUBING.

For cutting off a number of pieces of thin brass tubing I constructed the cut-off tool shown herewith. Two pieces of steel were selected of a size which, when fastened together by the three screws as shown, were about of the width and thickness of the lathe tools used with my machine. An ordinary



worn-out hack saw blade having the teeth ground off was then placed between the pieces and tightly clamped. This construction made an excellent cut off tool. The blade was so thin that the cut wasted very little stock, besides the cutters cost nothing and were easily procured. Milton Burgess.

Cleveland, Ohio.

* * *

In the new power house of the Interborough Rapid Transit Company, New York City, the 26,000 horse power of boilers now installed are soon to be equipped with economizers built by the B. F. Sturtevant Company, Boston, Mass. The twenty-eight economizers will contain 7,840 pipes having an aggregate length of nearly 15 miles. They will increase the heating surface of the plant about 25 per cent and store 265 tons of hot water or 18 per cent of the volumetric capacity of the boilers. It is estimated that the saving due to the utilization of heat in the waste gases will average more than 10 per cent for the whole twenty-four hours, which includes the time that the fires are banked.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

161. TO DRILL HARD STEEL.

To drill hardened steel make an old-fashioned flat drill and temper as hard as it will stand. Use camphor and turpentine in place of oil. I have drilled steel in this manner which I could not drill in any other way. G. E. HETZLER.

Dayton, O.

162. ALLOY FOR CALIPER AND GAGE ROD CASTINGS.

A mixture of 30 parts zinc to 70 parts aluminum gives a light and durable alloy for gage rods and caliper legs; the gage rods must be steel tipped for the alloy is soft and wears away too rapidly for gage points.

Howard, R. I. JAMES A. PRATT.

163. WHITING SURFACES FOR LAYING OUT WORK.

For laying out work on structural iron or castings a better way than chalking the surface is to mix whiting with benzine or gasoline to the consistency of paint, and then paint it with a brush; in a few minutes the benzine or gasoline will evaporate, leaving a white surface ready to scribe lines on.

Moline, Ill. ALBERT D. KNAUEL.

164. TO BLUE GUN BARRELS.

To blue gun barrels and other pieces dissolve 2 parts of crystallized chloride of iron; 2 parts solid chloride of antimony; 1 part gallic acid in 4 or 5 parts of water; apply with a small sponge, and let dry in the air. Repeat this two or three times, then wash with water, and dry. Rub with boiled linseed oil to deepen the shade. Repeat this until satisfied with the result. F. L. ENGEL.

New Britain, Conn.

165. BELT DRESSING.

A great many people think they know how to make a good belt dressing. This accounts for the many poor ones in the market. Here is one that will do about all the good that any of them will and none of the harm to the structure of the belt. Melt a pound of beeswax in a gallon of neatsfoot oil by a gentle heat. The most convenient way to secure a good mixture is to melt the beeswax first, then add the oil slowly, stirring it constantly until it is thoroughly mixed.

Neponset, Mass. OSCAR E. PERRIGO.

166. TO MAKE CHANGES AND CORRECTIONS ON BLUEPRINTS.

Some times I find it necessary to make changes and corrections on blueprints; to do this I use a solution of sodium carbonate and water, with a little red ink mixed in. This gives a very pleasing pink color to the changes which at the same time is very noticeable. The amount of sodium carbonate used depends upon the surface of the blueprint paper as some coarse-grain papers will look better if less soda is used and *vice versa*. However, the amount of powdered soda held on a five-cent piece dissolved in a bottle of water (Higgins ink bottle) gives very good results. R. F. KIEFER.

Sharon, Pa.

167. LUBRICATING MIXTURE FOR CUTTING TOOLS.

The proportion of ingredients of a lubricating mixture for cutting tools is 6 gallons of water, 3½ pounds of soft soap, and ½ gallon of clean refuse oil. Heat the water and mix with the soap, preferably in a mechanical mixer; afterwards add the oil. A cast iron circular tank to hold 12 gallons, fitted with a tap at the bottom and having three revolving arms fitted to a vertical shaft driven by bevels and a fast, loose pulley, answers all that is required for a mixer. This should be kept running all through the working day.

Manchester, Eng. H. T. MILLAR.

168. WATERPROOF CEMENTS FOR GLASS.

Probably the simplest and best aquarium cement (the formula for which is recommended by the United States Fish Commission) is made as follows: Stir together by weight 8 parts pulverized putty (dry whiting), 1 part red lead and 1 part litharge. Mix as wanted for use with pure raw linseed oil to a consistency of stiff putty. Allow a week to dry before using.

Another waterproof cement is made by dry mixing 10 parts each by measure of fine dry white sand, plaster of paris and litharge and 1 part powdered resin. Mix as required to a stiff putty with boiled linseed oil. The linseed oil must be free from any trace of adulteration with fish oil. It is sometimes necessary to boil pure raw linseed oil a few moments to drive off the water. A. L. GRAFFAM.

Indiana, Pa.

169. TO TEMPER SMALL COIL SPRINGS.

To temper small coil springs in a furnace burning wood the springs are exposed to the heat of the flame and are quenched in a composition of the following preparation: To a barrel of fish-oil 10 quarts of rosin and 12 quarts of tallow are added. If the springs tempered in this mixture break more tallow is added, but if the break indicates brittleness of the steel rather than excessive hardness, a ball of yellow beeswax about 6 inches in diameter is added. The springs are drawn to a reddish purple by being placed on a frame having horizontally radiating arms like a star which is mounted on the end of a vertical rod. The springs are laid on the star and are lowered into a pot of melted lead, being held there for such time as is required to draw to the desired color. A. L. MONRAD.

New Haven, Conn.

170. TO HARDEN STEEL WITHOUT SCALING.

Articles made of tool steel and polished may be hardened without raising a scale, thereby destroying the polish, by the following method: Prepare equal parts in bulk of common salt and (fine) corn meal, well mixed. Dip the article to be hardened first into water, then into the mixture and place it carefully into the fire. When hot enough to melt the mixture, take from the fire and dip or roll in the salt and meal, replace in the fire and bring to the required heat for hardening. Watch the piece closely and if any part of it shows signs of getting "dry" sprinkle some of the mixture on it. The mixture, when exposed to heat, forms a flux over the surface of the steel which excludes the air and prevents oxidation, and when cooled in water or oil comes off easily, leaving the surface as smooth as before heating. Borax would possibly give the same result, but is sometimes difficult to remove when cold.

Rock Falls, Ill. E. C. NOBLE.

171. CEMENT FOR LEATHER BELTS.

In an ordinary glue-pot soak over night a pound of good fish glue in a pint of cold water. Heat this up, stirring until completely dissolved. Then add one ounce of dry white lead. When the mixture has been again thoroughly stirred and is nearly cool, add one ounce of grain alcohol, and stir it well in. Heat up the cement again when it is wanted for use. In the use of this cement care should be taken to have the laps freshly and smoothly cut, and as clean as possible. The cement should be evenly spread with a brush over both surfaces and the surfaces placed in contact as quickly as possible, and on each side of the lapped belt should be placed a previously warmed board and the whole clamped together for an hour or two according to the width of the belt, its thickness and the amount of strain it will have to stand. This cement can be made in larger quantities by observing the same proportions, and when cool it may be cut up into small pieces and kept in good condition in a fruit jar tightly closed. When it is wanted it will not be necessary to heat up more than is wanted for the job in hand. OSCAR E. PERRIGO.

Neponset, Mass.

* * *

Grease is a valuable lubricant where machinery is running in a dusty atmosphere, because of its sealing quality when used in a compression grease cup. Fed into a bearing it forces out along the shaft and effectually prevents the intrusion of grit. Unfortunately its coefficient of friction is high and where efficiency of transmission is important the use of grease is not an attractive proposition. Locomotive tests made in the Pennsylvania Railroad System's testing plant at the St. Louis Purchase Exposition showed that the use of grease on the driving axles increased the friction from 75 to 100 per cent.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

15. E. M. P.: I should like disinterested advice from your readers as to the best type of power hammer for the blacksmith shop of a bridge shop where but one hammer is required and the work includes forging of small tools as well as general work running up to bars as large as 6 x 5 inches.

We ask for suggestions from our readers.

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16. J. S. P.—The accompanying cut shows three tangent circles, E, E_1 and E_2 drawn within and tangent to the bounding circle $A\ B\ D$. Give a general formula for solving R when r is known.

A. Draw the radius $B\ C$ through the center of one of the smaller circles, say E, and the radius $A\ C$ tangent to it. Draw the radius $c\ f$ perpendicular to $A\ C$. Then

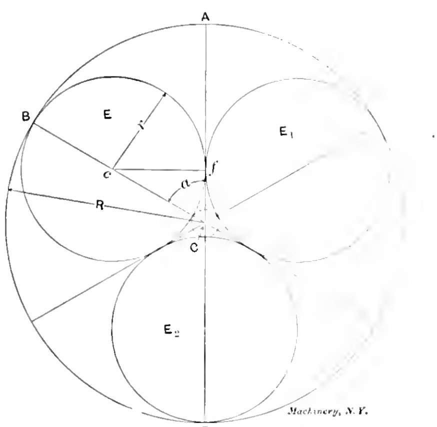
$$R = r + \frac{r}{\sin a}, \text{ or } R = r + r \operatorname{cosec} a$$

in which

R = radius of bounding circle.

r = radius of tangent circles.

a = angle subtended at center, or $360 \div 2n$, n being the number of tangent circles.



With three tangent circles as shown angle $a = 60$ degrees, and if, for example, $r = 0.232$ it follows that

$$R = 0.232 + \frac{0.232}{0.866} = 0.5$$

and the ratio of R to r is as 1 is to 0.464. The following table gives the ratio of maximum tangent circles from 3 to 16 inclusive, the radius R of the bounding circle being 1:

No. of Circles.	$2r$	No. of Circles.	$2r$
3	0.464	10	0.236
4	0.414	11	0.219
5	0.370	12	0.206
6	0.333	13	0.193
7	0.302	14	0.182
8	0.276	15	0.172
9	0.255	16	0.163

The radius of the inner circle, denoted by the dotted line, will be the difference between R and $2r$, of course, or 0.036 in the above example.

17.—I. H. C.—Can any of your readers inform me how to drill chilled cast iron giving full details of the process?

A.—Referred to H. J. Bachmann, who replies: "I witnessed some years ago the drilling of a lot of small iron castings for toy work that had become accidentally chilled at the spot where the hole was to be drilled. The drills were hardened at the first trial by inserting them while red hot in a stick of sealing wax, which made them quite hard, but not hard enough to drill completely through the casting before becoming dull. All the various known lubricants were tried, but they all seemed to have the effect of glazing the work and thus retarding the drilling. As a last resort the drills were hardened as described in the recent issue of MACHINERY for drilling hardened steel, and instead of using liquid lubricant a strong blast of compressed air was used to keep the point of the drill cool, because of the well-known fact that the edge of any cutting tool made of carbon steel will last longer when the heat is conducted away from the cutting point." The receipt mentioned by Mr. Bachmann for drilling hardened steel was contributed by him to the February number of MACHINERY. The directions were to harden in sulphuric acid, the pure acid being placed in a dish to the depth of about ¼ inch and the drill being heated and dipped into the acid to that depth, making the point extremely hard while the remainder remains soft.

A KINK IN DIVISION.

Robert Grimshaw writes: By the machinist and apprentice no arithmetical operation is more frequently encountered than the division of inches and fractions thereof by two, as in laying off center lines, spacing, etc. While the division of an even number and a fraction by two is easy enough to almost any one, it is surprising to note how much "fussing" is done by many over the division of an odd number and a fraction.

The following method is very convenient:

To divide an odd number and a fraction by two write the expression in the ordinary manner, draw a line beneath it and add together the numerator and denominator of the fraction, placing the sum in position for the numerator of the fraction of the quotient. For the denominator of this fraction multiply by two the denominator of the fraction which is being divided. Deduct one from the whole number of the expression that is being divided, and divide the remainder by two. The following examples will show clearly how the method is operated:

$$\frac{31\frac{31}{32}}{15\frac{63}{64}};\quad \frac{1\frac{1}{32}}{\frac{33}{64}};\quad \frac{7\frac{19}{33}}{3\frac{52}{66}};\quad \frac{19\frac{57}{141}}{9\frac{198}{282}}$$

* * *

The efficient working of a machine tool depends upon how rigidly the work and cutters are supported, and another factor that is important is weight. No matter if the frame of the machine is very rigid, if it lacks weight, there is likely to be more or less vibration when the cut is of intermittent nature. The adding of iron to secure mere weight without adding materially to the strength requirement is costly and undesirable, although in a measure it must be done in the making of most machine tools. An alternative and usual plan is to make up for want of weight by a heavy foundation, but in some classes of tools the foundation is too far removed from the zone of cutting action to materially help in preventing vibration. The growing use of concrete for almost all constructive purposes has suggested that the waste interior space in many machine frames could be profitably employed by filling it full of an approved concrete mixture which would have the merit of cheapness and would give the machine the weight and solidity that is so beneficial in getting a smooth cutting action. In the case of a heavy engine lathe, for example, which has a bed extending to the floor, the whole interior space of the bed could be filled up with concrete, thus adding many hundred pounds to the weight of the machine and at the same time stopping the nuisance of having the space employed as a "catch-all" for chips, waste, clamps and blocking of all kinds.

* * *

Mr. E. E. Wood has recently accepted the position of general manager for Geo. D. Walcott & Son, of Jackson, Mich., builders of machine tools. Mr. Wood was formerly general superintendent of the Jones & Lamson Co., Springfield, Vt., and was later connected as a special sales agent with the Niles-Bement-Pond Co. and the Pratt & Whitney Co., which connections he severed to accept his new position.

* * *

The shop receipt No. 147 "Alloys for Drawing Colors on Steel" which appeared in the February issue was erroneously credited to Max Dehne; the contributor was Max J. Ochs.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

HENDEY-NORTON LATHES.

Two new products of the Hendey Machine Co., Torrington, Conn., are shown in the accompanying illustrations. The first is an all-geared head stock lathe, Figs. 1 and 2, and the second is a modification of their belt-driven standard type lathe, which is now fitted with a tie-bar reinforcement of the lathe head, Fig. 3. Both of these designs have been developed for the purpose of securing stiffness and power for high-speed steel work and the desired results have been accomplished without making the lathes more cumbersome or clumsy to operate, which cannot be said, by the way, for some of the efforts that have been put forth to meet the new high-speed steel conditions.

The head-stock of the geared drive lathe is compactly built with no overhang outside of the limits of the gear box and the back gears of the ordinary lathe. It is of the same length as the regular pattern head and the construction of the main spindle and bearings is identical in both types. Power is transmitted to the drive through the single driving pulley *A*, Fig. 2, and is transmitted to any one of the nest of four gears which turn together as a unit and run loose in the main spindle unless locked with it by the clutch. The sliding rocker, *C*, on shaft *B* carries transfer gears (not shown) which may be brought into mesh with the desired cone gear by the movement of a handle projecting through the slot *K* at the front of the head stock. This handle controls the position of the rocker in a manner similar to the well-known arrangement in the Hendey-Norton feed box. There are eight mechanical changes of speed for the spindle, four direct and four running through the back gears. The back gears are permanently in mesh with their mating gears, which revolve freely on the spindle. The change from direct to back geared drive is made by the clutch working between the large gear of the cone and face gear, the clutch being operated by the lever at the front end of the head stock.

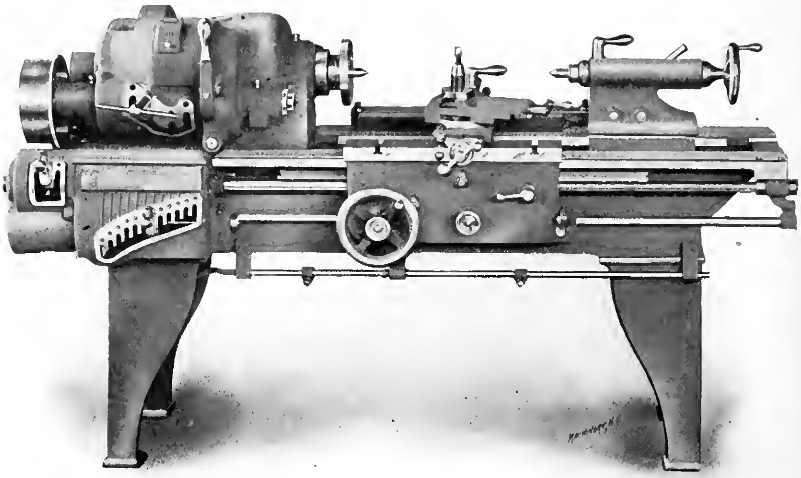


Fig. 1. Hendey-Norton Lathe with Geared Head.

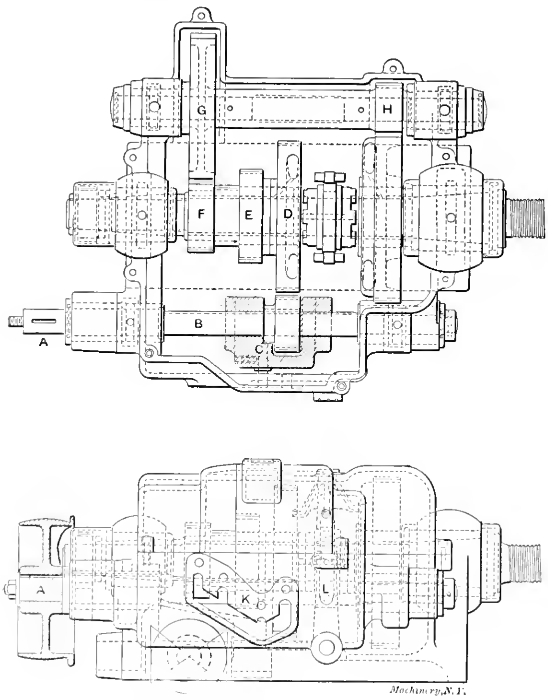


Fig. 2. Details of Geared Head.

A feature of the head-stock of this lathe is the arrangement for oiling all of the bearings while the lathe is running. In the case of the main bearings of the spindle, and of the back gear and pulley shafts, this, of course, is easily accomplished, since the several bearings are easily accessible from the outside of the casing for oiling, and in addition are equipped with the usual ring oilers with which the Hendey Machine Co. fit the main bearings of their lathes. The face gear and the cone gears on the main spindle, however, both of which run loosely on the spindle at times and are enclosed by the casing, are not so accessible and special provision had to be made for oiling. As apparent in Fig. 2, annular grooves are cored in the face of the large cone gear and of the face gear. These grooves are so shaped as to retain oil, both when the gears are stationary and when running, and by suitable oil channels this oil is carried to the shaft. By raising a small cover on top of the casing oil can be easily supplied from an oil can to either of these annular grooves regardless of whether the gears are at rest or in motion.

A positive clutch instead of a friction clutch is used and all the gearing is of steel except the large face gear and the large back gear. Changes of speed and the throwing in or out of the clutch can safely be accomplished without stopping the driving shaft, except to slow down for the highest speed changes. The heavy construction of this head coupled with the steel gearing makes the lathe effective for all conditions of work with high speed steel and numerous tests made at the factory show the power to be ample for any requirement.

The tie-bar, which is now used on the head stocks of the standard type of Hendey-Norton lathe, is for the purpose of stiffening the front bearing, making it capable of supporting the spindle under heavy duty conditions with absolute rigidity. Although the front bearing and its support have been made unusually heavy in the standard lathe, it was found that it could be sprung an appreciable amount under heavy cuts with high-speed steel, especially in chucking work. Under such conditions there is also a tendency for the spindle to be driven into the conical seat of its bearing with a great deal of pressure which, coupled with the slight deflection of the bearing due to the end thrust, tends to bind the spindle and cause it to run hard. This is overcome by the use of the tie-bar. Although in appearance the tie-bar looks strange to a

mechanic at first, it seems to be the verdict of those who have become accustomed to it that the lathe really looks bare and incomplete without it. At least the writer can testify that after having spent an hour at the factory of the Hendey Machine Co. where this new type of lathe was largely in evidence, the old style looked about as strange to him as the new style

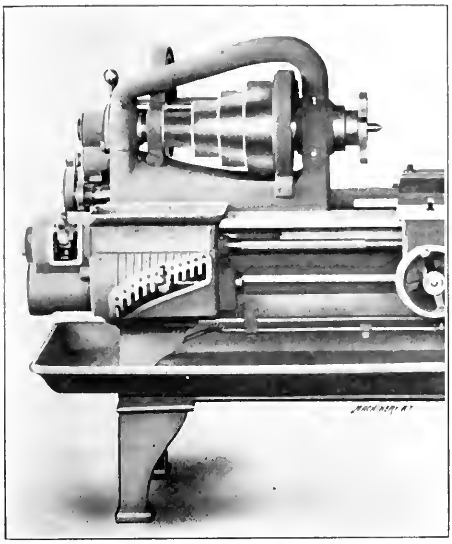


Fig. 3. Tie-bar Headstock used on Hendey-Norton Lathes.

did when he first saw it. It in reality seems to be as useful an adjunct to the lathe head, and perhaps even more necessary, than the tie-bar used for the head of a milling machine; for although the thrust is heavy in end milling and in boring on a milling machine, it is scarcely greater than is met with in work that now is accomplished in the engine lathe.

THE "EXACTO" PACKING GAGE AND CUTTER.

The purpose of this device, shown in Fig. 1, is to facilitate cutting off square or round packing to exact length with the ends beveled in the proper manner, as shown in Fig. 2, the claim being that a stuffing box packed in this way will give better satisfaction than with ring packing, allowing at the same time a greater range of choice as to materials. As all the rings cut in this apparatus are of exactly the same size, there is no possibility of waste from errors in cutting, no loss of time in fitting the packing to the rod, and, as the packing is right, a tight joint and a workmanlike job is assured.

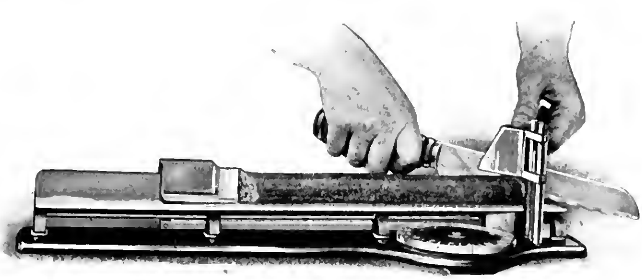


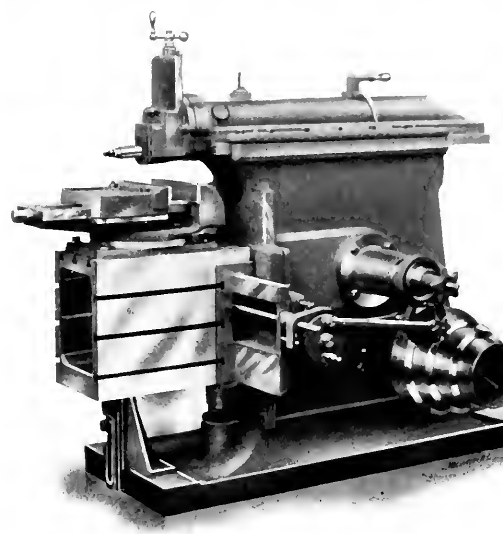
Fig. 1. "Exacto" Packing Gage and Cutter in use.

Fig. 2. Form of Packing Ring Produced

The method of operation will be readily understood. The graduated dial shown is set to agree with the diameter of the rod plus the diameter of the packing. For instance, if the rod is 2 inches in diameter, and the packing 1 inch, add them together and set the dial at 3 inches. This locates the bevel gage at such a position that the packing is of the right length to just fill the required space. The packing is now inserted in the trough of the device with its beveled end resting in the gage; after the gage is set the proper length it may be secured by a setscrew to preserve the setting for as many rings as it may be desired to cut. After inserting the packing it is held in place by placing the thumb of the left hand upon the knife guide, and is cut with a knife having a serrated edge. The knife is furnished with the outfit. The device is sold by Green, Tweed & Co., 17 Murray St., New York.

TWENTY-EIGHT INCH BACK-GEARED CRANK SHAPER.

The accompanying half-tone shows a shaper which has been designed by the American Tool Works Co. of Cincinnati, Ohio. It is one of a new line, built by this concern to meet the changed conditions which the shaper, which was formerly regarded as a tool-room machine, now has to meet. It is built to stand severe requirements in heavy manufacturing and is of sufficient strength and rigidity to use high speed steels to their best advantage. The column is strongly braced internally and is reinforced outside on the line of strain by a wide deep rib cast integral with the wall. The ram bearing pro-



Twenty-eight inch Back-geared Crank Shaper.

jects out at both the front and the rear. The base is of the extension type with a pad at the end to receive the table support, and is provided with raised rim to hold oil drippings, thus protecting the floor. The ram is designed for uniform rigidity throughout the entire length of stroke, is thoroughly braced by internal ribs and has long wide bearings with a tapered gib for taking up the wear. The stroke of the ram is positive and has 8 rates of speed, ranging from 15 feet to 181½ feet per minute with full stroke. The length of the stroke may be changed at will without stopping the machine. The device for positioning the stroke is located near the head and may be operated while the machine is running. The machine is readily changed from single to back geared drive by operating a convenient lever and it has the unusual back gear ratio of 1 to 29.4, giving it great power for taking heavy cuts. The slide on the head is fitted with a tapered gib, has a large

tool post for using holders with inserted cutters, and a tool-steel tool-post screw and serrated back plate.

The table is a box form with T-slots on back and sides, planed from the solid metal, is braced internally, and is fitted to the apron by a method which ensures accuracy and stiffness and at the same time allows it to be readily detached. The apron is accurately fitted to the cross rail and is provided with taper gib for taking up the wear; when the table is removed, work may be clamped to the face of the apron, three T-slots being provided for this purpose. The cross rail is of box form, heavy and strongly ribbed, and is secured to the column ways by clamps and plates in such a way to prevent it from dropping when the binder bolts are loose. The crossrail is provided with a telescopic elevating screw of large diameter provided with ball bearings.

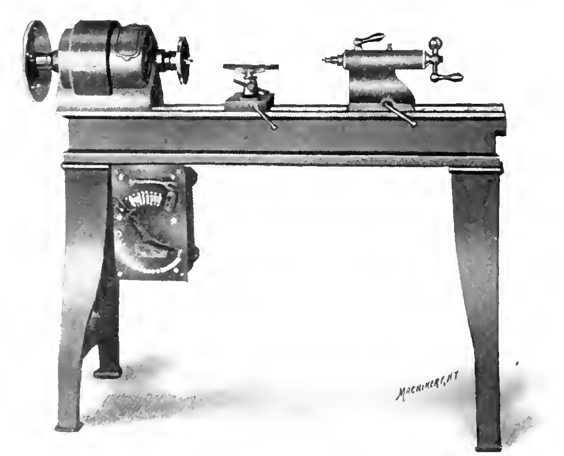
The cross feed has a range of from 0.0114 inch to 0.250 inch with quick adjustment for any desired feed. It adjusts itself to any elevation of the rail. The reversing of the feed is accomplished by turning the knob shown in the cut without stopping the machine. The vise covers nearly the entire area of the table top and has wide deep jaws faced with steel. The table support is clamped to the base and has an adjustable slide carrying a roller at the top which rests on a planed way at the bottom of the table, a design which protects the roller from riding over accumulated chips or dirt. This table support is not a part of the regular equipment, but is furnished at extra cost.

The driving shaft journals are bushed with bronze. All shafts are of high carbon crucible steel accurately ground and the points of danger are amply covered to prevent injury to the operator. The regular equipment includes vise, countershaft, and all necessary wrenches. When specified and at extra cost, the makers are prepared to furnish power downfeed to the head, a circular attachment, mold makers vise, tilting table, four speed gear box, and an improved motor drive.

The length of the stroke of this shaper is 28½ inches, the down feed of the head is 9 inches, the vertical travel of the table 13¼ inches, horizontal travel of the table 31 inches.

MOTOR-DRIVEN SPEED LATHE.

The accompanying half-tone shows a motor driven speed lathe of pleasing design. The motor is mounted directly on the bed of the lathe taking the place of the belt driven head stock generally used, and has the spindle of the machine for its armature shaft. The rheostat is mounted under the head



Fay & Scott Motor-driven Speed Lathe.

stock in a convenient location. The fields of the motor are made in accordance with a patented design which gives a large ratio of spindle speeds without sacrificing the efficiency of the mechanism. The spindle is journaled in taper bearings of bronze with convenient adjustment for taking up wear and end thrust. The size shown swings 10 inches over the bed and 5½ inches over the rest holder, and has a rheostat which gives 12 motor speeds ranging from 800 to 3,000 revolutions per minute with a ½ horse power motor connected to a 110 volt direct current. The spindle has provision for a face plate at the rear for large diameter turning and has a 9/16 hole throughout its length. The beds are made in lengths of 4, 6 and 8 feet with a net weight of 459 pounds for the four-foot size. With each lathe is furnished one pair of spur centers, one rosette or screw center, three rests of different lengths for turning, and two face plates. This machine is made by Fay & Scott, Dexter, Maine.

ADJUSTABLE ROUGHING AND FINISHING REAMERS.

R. M. Clough, of Tolland, Conn., makes the adjustable roughing and finishing reamers illustrated below. Fig. 1 shows the roughing tool. It is made with four blades of small enough diameter to allow a slight amount for a finishing chip, and with cutting surfaces at the ends of the blades as well as on the outside edge. The finishing reamer, Fig. 2, has six blades unevenly spaced with the bottom of the slot on an incline. The rear ends of the blades are dove-tailed to an adjustable

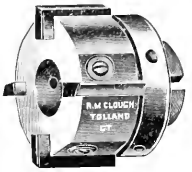


Fig. 1. Roughing Reamer.

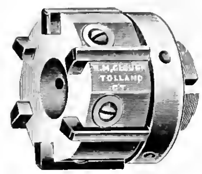


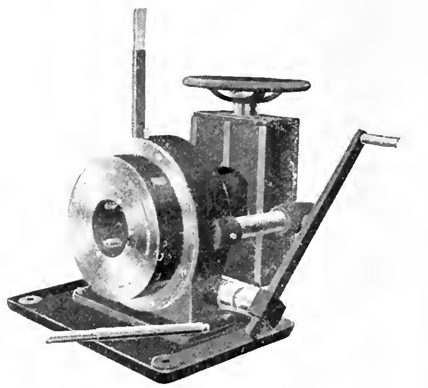
Fig. 2. Finishing Reamer.

threaded bushing which serves to move them in or out together in the inclined slots, and thus varies their diameter. The total variation obtainable for a given reamer is ¼ inch. The design of the adjusting mechanism is such as that the blades are drawn very firmly to the bottom of the slot.

This reamer is known as "style D," and is designed particularly for reaming motor cycle and automobile cylinders. They are made in sizes from 2 to 6 inches in diameter.

THE LOEW VICTOR PIPE MACHINE.

The pipe threading machine shown in the accompanying half-tone is built by the Loew Mfg. Co., Cleveland, Ohio, in three sizes, covering a range of from ¼-inch to 6-inch pipe. It is solidly constructed and designed to resist rough usage, yet is so light as to be conveniently portable, weighing less than other machines of its kind and requiring considerably



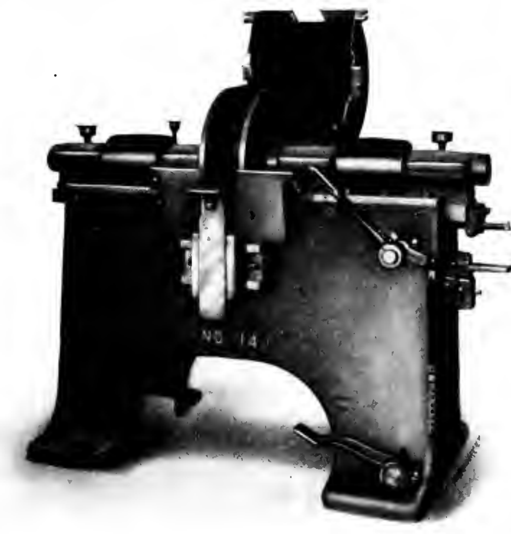
A Compact Hand Pipe Threading Machine.

less space. It comprises a two-jawed vise operated by a hand wheel and longitudinally movable by operating the lever shown at the back of the machine, together with a revolving die head. The die head is rotated through a double thread worm gear instead of by bevel gears, as is the usual practice. The two larger sizes are equipped with outside gear wheels encased in a guard, giving the machine two speeds, either to be used as desired, depending on the size of the pipe being cut. The dies, which are in four pieces, are of high grade die steel and are so shaped that they can be reground by the user, thus making it unnecessary to return them to the factory when they are dull. The grinding does not change the shape of the cutting face of the dies. The head is self locking and is so designed that during the operation of cutting the thread

the pressure of the pipe against the die prevents all danger of disturbing the adjustment. No levers or locking devices are required and there are no projections on the faceplate. In operation it is unnecessary to reverse the machine and back the pipe out of the dies. When the end of the cut is reached the hand bar shown is inserted in a hole in the edge of the face plate, when the continued operation of the crank opens the dies, at the same time cleaning off the burrs from the tnread.

DOUBLE HEAD DISK GRINDER.

This grinder, shown in the accompanying half-tone, is designed to finish two opposite faces of the work presented to it at the same time. For this purpose the work is mounted on an adjustable table between two disk wheels which are independently driven and have suitable means for moving them toward or away from each other. The lever shown at the right actuates a pinion which meshes with two racks, one above it, the other below, which in turn are connected to the right and left hand heads respectively. Thus a downward pressure on the lever or the pedal which is connected with it brings the two grinding disks toward each other for performing the desired operation on the work. Both heads can be clamped in any position. The lower rack can be dropped out of mesh and the left hand head locked, thus allowing only the right hand head to be moved to the work.



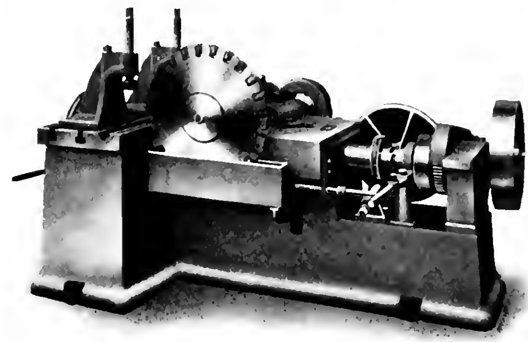
Double Head Disk Grinder.

The reason for making both heads movable by the lever is that it is sometimes necessary to grind off more from one side of a piece of work than from the other, or the two opposite sides may not be of equal area, in which case the grinding will not be done at all evenly. Under either of these conditions the work is secured in a holder and the center rest is so adjusted that the right amount can be ground off on each side. The wheels are brought back by the spring shown, which is attached to an adjustable lever, thus permitting the operator to use the foot pedal and devote both hands to handling the work. There is a back stop to prevent the wheels from moving back too far and a screw stop which regulates the forward movement of the head. The foot lever is connected to the rack gear shaft by sprockets and a chain, the latter being adjustable to take up back lash.

The wheels are covered with a cast iron hood, the top half of which is hinged at the back and locked at the front with hinged bolts and thumb nuts. The opening in the front for inserting the work is 8 inches by 12 inches. Adjustable sheet metal shields are used which are attached to the hood with thumb screws. With these the opening can be reduced to any size desired. At the back of the machine is a flanged opening from the bottom of the gap in the bed for connecting the exhaust pipe. The machine weighs about 3,500 pounds and has practically the same dimensions as regards driving power, spindles, wheels, etc., as the No. 4 grinder, built by the same makers. The wheels are 20 inches in diameter by ¾ inch thick. The greatest distance between the wheels is 14 inches, the least distance zero. The Gardner Machine Tool Co., Beloit, Wis., are the builders.

NEWTON COLD SAW CUTTING-OFF MACHINE.

The accompanying half-tone shows a No. 3 bar cold saw cutting off machine fitted with a 26-inch Taylor-Newbold inserted tooth saw blade. The machine is the product of the Newton Machine Tool Co., Philadelphia, Pa., and has a capacity for round stock up to 8 inches in diameter and for square stock up to 7 inches. The saw is driven through spur gearing by a worm and worm wheel of steep pitch running in a bath of oil. The driving gearing has a ratio of 22 to 1 with



Newton 26-Inch Cold Saw Machine.

a belt capacity of 6,000 square feet per minute, being specially designed to give the power required to operate the saw to its fullest capacity. The saw carriage has a variable automatic feed through disks with power quick return for withdrawing the saw blade from the cut. Automatic stops are provided in both directions and a special table will be furnished if desired for cutting off T-rails. In the shops of the manufacturer the machine has cut off forgings of 45. carbon stock 6 inches in diameter in 4½ minutes.

FOOT POWER CORE CONING MACHINE.

The foot power core coning machine shown in the accompanying cut has been designed to fill the demand for a machine to finish the ends of stock cores as made on modern core machines in core rooms with no power available. The gage is so arranged as to give a standard taper of 3/16 to the inch on the side or ⅜ to the inch difference in diameter, and with the gage any length of core can be used to suit the required conditions. Various standards have been proposed at different times for core prints different from the standard proposed by the manufacturers of this machine, but after considerable experimenting the makers adopted this in their own factory and have sold quite a number of machines adjusted to this standard, to the entire satisfaction of the users.

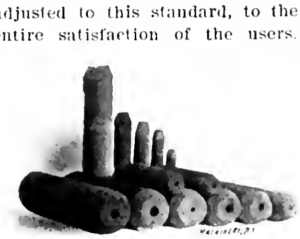


Fig. 1. Cores with Coned Ends.

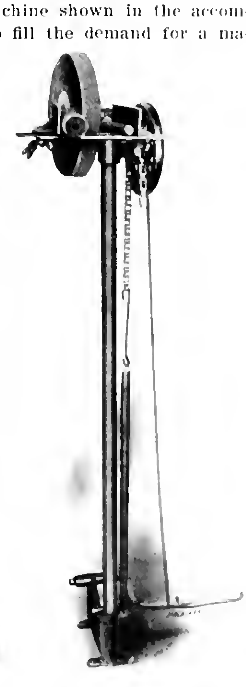


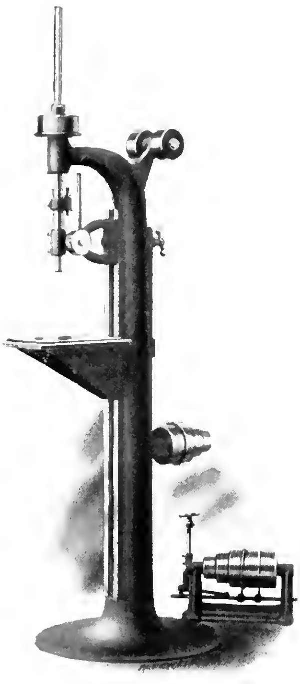
Fig. 2. Core Coning Machine.

The fact that the emery wheel is revolved by foot power allows both hands to be used in turning the core around and holding it against the gages, a thing difficult to do with one hand only. The gages are quickly changed, and on the machine illustrated give a capacity of from ⅜ inch to 3¼ inch diameter. Each side of the emery wheel is used for the cone while the front may be used as an emery grinder. The wheel used is 8 inches in diameter by 1¼ inches face.

Fig. 1 shows some samples of the work done by the machine. The Falls Rivet and Machine Co., Cuyahoga Falls, Ohio, are the builders.

FOX SINGLE SPINDLE SENSITIVE DRILL.

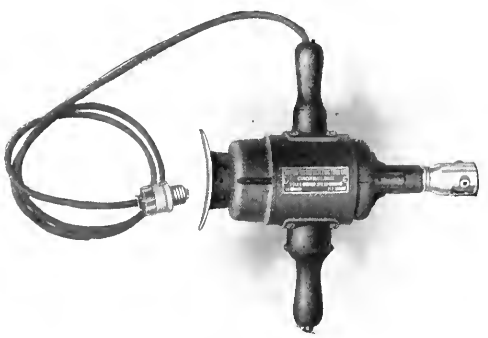
Among the features of this new drill is the fact that the frame is composed of a very strong one-piece casting with a base 21 inches in diameter. The table has 26½ inch vertical adjustment. The spindle is counterbalanced by a quick acting spring and the spindle bracket is clamped by a straight pull from the back instead of from the side, as in former designs, hence there is no tendency to spring the spindle out of line. Long bushings are used in the upper cone bearings. An adjustable collar in the spindle sleeves provides an accurate depth gage. The table has an oil groove around its edge and is conveniently locked in position by an eccentric clamping lever which gives a quick and positive action. The countershaft carries a three-step cone pulley and tight and loose pulleys arranged on novel lines, the tight pulley and the cone pulley being in one piece and revolving loosely upon a fixed shaft in the same manner the loose pulley does. This machine is built by the Fox Machine Co., 815-825 North Front Street, Grand Rapids, Mich.



Fox Single Spindle Sensitive Drill.

SINGLE SPEED ELECTRIC DRILL.

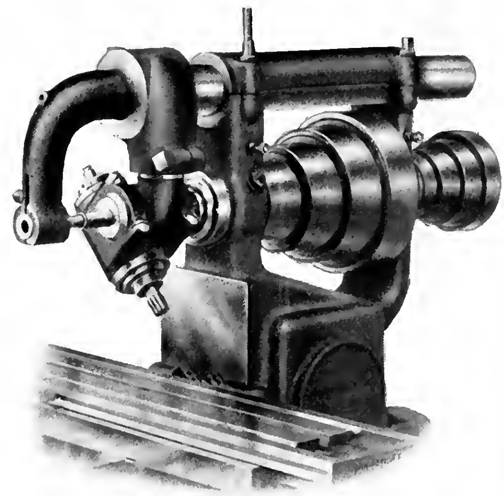
Besides the line of variable speed drills made by the United States Electric Tool Co. of Cincinnati, Ohio, they have recently put on the market a complete line of single speed drills of which an example is shown in the accompanying cut. These tools are comparatively light in weight and much smaller for a given size, and are powerful and efficient as well. The tool is easy to operate, being provided with two handles opposite each other in one of which the current enters, while the other is provided with a push-button switch. The tool will be furnished either with a wooden spade handle or with a nickel alloy breast plate so arranged that it may be set at any angle the operator may choose. The armature shaft is provided with a fan which constantly draws a current of air through the perforated end plate, circulating it through the inside of the motor and exhausting from the front end thus cooling both the armature and drill. This feature is provided with all the drills made by this firm, both of the single and variable speed type.



Single Speed Electric Breast Drill.

VERTICAL ATTACHMENT FOR THE FOX MILLING MACHINE.

Fig. 1 shows a new vertical attachment recently designed by the Fox Machine Co., 815-825 North Front St., Grand Rapids, Mich. One of its novel features is the fact that it provides for adjustment transversely, that is, in line with the main spindle. It will swivel through an arc of 90 degrees from vertical to horizontal, and by reversing it upon the spindle and overhanging arm it will swing between the vertical and horizontal positions on the outer side, thus giving a full range of 180 degrees. A graduated dial shows the angle at which the spindle is set. The spindle is extra heavy and is provided with a draw-in bolt for collets and mills; it has a No. 7 Brown & Sharpe taper hole. Its bearings are provided with convenient means for taking up wear.



Fox Vertical Milling Attachment.

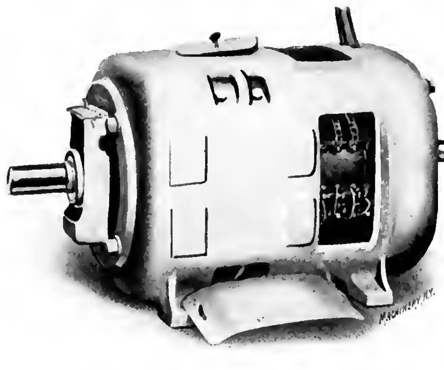
The No. 3½ milling machine on which vertical attachment is shown mounted has been recently improved in a number of particulars. A change has been made in the feed mechanism by which the hand rack feed is placed at the left; a ratchet lever is substituted for the ordinary type heretofore used. The spindle design has also been improved.

WESTERN ELECTRIC HOISTING MOTORS.

The Western Electric Co., Chicago, Ill., in accordance with their policy of specializing their motors to suit any service for which there is a considerable demand, have recently developed the type "H" crane motor line, of which an example is shown herewith. The crane motor is required to work under unusually discouraging conditions. It is placed in restricted space, must be of low speed to reduce the gear ratio to a minimum, and must be able to withstand great overloads and sustain severe shocks. A type of brake capable of stopping the motor almost instantly is often used, producing a very heavy strain in armature shaft. The service is often such as to render it necessary to enclose the motor, thus requiring that it be designed with a wide margin of safety. These various conditions require careful mechanical and electrical design, together with the use of the best materials obtainable for the purpose desired.

The governing factor in the operation of a crane motor is

the torque required by the load. The torque of an electric motor is directly proportional to the magnetic flux and the current flowing through the armature. In a series wound motor the flux is increased in almost direct proportion to the current up to the point of magnetic saturation, and the torque thus developed is proportional to the square of the current. Beyond the saturation point the torque does not increase so rapidly; the speed at the same time decreases with the in-



Western Electric Hoisting Motor.

creasing load—a valuable characteristic of this type, as it does not make the speed of the motor dependent on the judgment of a perhaps ignorant operator. These advantages of the series wound motor have been accentuated in the "H" design to which this description refers. The magnetic circuit is of large area, and its low density under normal conditions permits a great increase in flux for a heavy load before the saturation point is reached. The armature has little reactance upon the field, permitting the machine to run under wide changes of load without sparking.

The losses by heat in a hoisting motor have to be reckoned with somewhat differently than for other motors for constant service. When a heavy load is being lifted great quantities of heat are liberated, a large part of which must be radiated during the operations of stoppage and lowering of the load, when no heat whatever is generated. If it were possible to operate the motor continuously for the load which it is called upon to carry intermittently, the temperature would soon reach a dangerous degree of heat. Study along these lines is necessary before a suitable motor can be selected for any given service. In rating these motors, therefore, the time of operation is of equal importance with the load, and for this reason they are not rated on the basis of output alone. From the nature of the design these machines are somewhat costlier than those of similar sizes in the constant-speed class, but as the electrical portion of any hoisting equipment is usually a small part of the total cost, this slight increase, which adds greatly to the general efficiency, will be well repaid.

SELF-DEMAGNETIZING ELECTRO-MAGNETIC CLUTCH.

This clutch, built by the Pick Electric Co., 4 and 6 Warburton Ave., Yonkers, N. Y., has as a special feature the fact that trouble due to residual magnetism has been eliminated. When applied to a planer in the manner shown in Fig. 2, with the table running light, on cutting off the current from the clutch, the friction surfaces at once separate, allowing the driving gears to stop. This is accomplished even though the design is such that the magnet face and the armature are in direct contact with each other when the coils are excited, and is an evidence that there is little tendency for the coil to attract the armature when the circuit is broken.

The arrangement shown in Fig. 1 has been especially designed for such service as planer driving. Power is applied to shaft *A* on which are mounted a spur gear and a sprocket which drive respectively gears *D* and *E*, which are loose on shaft *B*. Keyed to shaft *B*, from which the planer is driven, is the member *C*, either side of which may be energized by a weak current from the controlling switch. If the right hand side be energized, *C* and *E* will be drawn together with sufficient force to drive shaft *B* from shaft *A* through the Morse chain and sprocket, as shown, giving a comparatively low rate of speed for the cutting movement of the table. When the table reaches the end of the cut the dog, instead of throwing a shipper as usual, trips a switch, transferring the energizing current from the right to the left hand side of member *C*, thus bringing *C* and the armature *D* into contact. Armature *D* is driven by the gearing in an opposite direction and at a faster rate of speed than *E*, and the table is thus returned ready for another cut. The tripping of the switch at the rear end of the stroke again starts the table forward. As seen in actual operation, the clutch showed no evidence of trouble from residual magnetism, and stopped the table with remarkable accuracy, bringing it to within a fraction of an inch of the same point each time the reversal was made. With the ar-

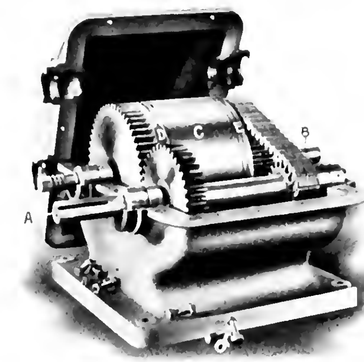


Fig. 1. Electric Reversing Clutch, with Cover Removed.

rangement shown a variable speed motor was used.

The driving gears and chains run in oil. The clutch does not need adjustment, is dust proof, noiseless and self lubricating. The exciting current may be varied so that the clutch will transmit a given power and will slip when the load is exceeded. The use of this device is, of course, not confined to planer reversing mechanisms, but may be used as well for a main line coupling, as a clutch pulley on the countershaft to drive individual machines, or as a disconnecting or reversing

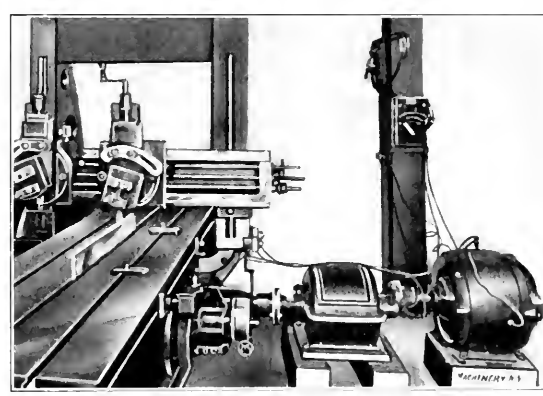


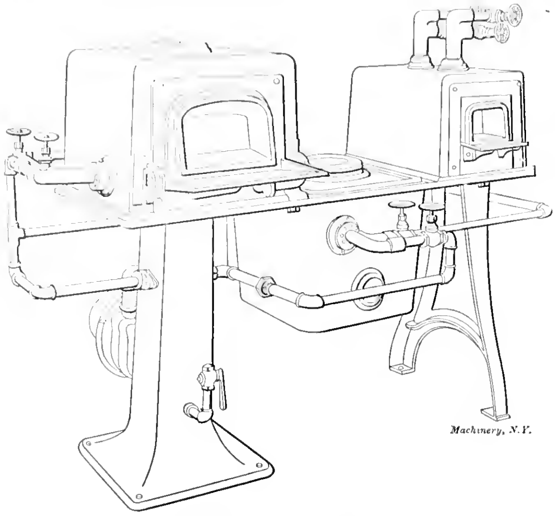
Fig 2. Electric Clutch Applied to Planer.

clutch on automobiles, hoisting engines, etc. In such cases a push button takes the place of the usual clutch lever.

COMBINATION GAS FURNACE.

The furnace shown in the cut combines a muffle furnace, a forge and a crucible furnace. In the muffle section the flame is projected from a double burner into the chamber encircling the muffle. The design of the lining is such that a rotary motion is imparted to the flames, distributing the gases over the enclosed space and heating the muffle rapidly and evenly. This is a desirable arrangement for use in heating dies, milling cutters and other expensive tools. They can be hardened perfectly without danger of cracking or overheating, because of the even temperature maintained throughout. The combustion chamber of the forge section is circular in form and so

arranged that the flame is distributed in much the same manner as is done with the muffle furnace. The crucible section is especially adapted for heating a lead bath. This may be kept at uniform temperature for an indefinite period with a minimum consumption of gas. Small pieces can be heated very quickly and by keeping the temperature of the bath at the right point overheating is eliminated and uniformity secured.



Combination Gas Furnace.

For tempering a crucible similar to that for the lead bath may be used, filled with oil and maintained at the proper heat for drawing the temper to the required point, the temperature being read from a thermometer suspended in the oil. This furnace is made by the Chicago Flexible Shaft Co., Chicago, Ill.

* * *

ANNUAL CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION.

The eighth annual convention of the National Metal Trades Association was held at Cleveland on Wednesday and Thursday, March 21 and 22, with headquarters at the Hollenden. There was a large attendance with an unusually representative list of members from nearly every section of the country. The first regular session was on Wednesday morning, but previous to this the officers and members of the council had been clearing the boards of routine business so that action upon important matters was not delayed by mere business routine when the convention actually opened.

On Wednesday morning's session, following the usual address of welcome, came the reports of the officers showing the association to be in good financial condition and that the membership had increased very largely during the past year. Secretary Wuerst's report laid special stress on the fact that the work of the association has been almost exclusively confined to preventing, rather than combating strikes, and that the efforts in this direction had worked as much for the benefit of the employees as for the employers; and it has been demonstrated that the association will stand by and aid employees in securing their rights. Favorable comment was also made on the results secured through the special contract operatives employed by the association. These services are made use of by the association previous to the calling of and during strikes when their suggestions as skilled mechanics have resulted beneficially in many ways.

One of the most important questions to come before this year's meeting was that of a plan for co-operation between the National Metal Trades Association and National Founders Association. The committee appointed a year ago formulated a plan that had been adopted by the councils of both associations and was adopted at the last meeting of the National Founders Association, the contention being that it would save a heavy expense in the administration of the business of the two organizations. It was recommended that both associations should hold the annual convention at the same place, on consecutive days, that the offices of both should be in the same building and under the same direction; and that while the officers could be independent, the work of the two societies should be carried on jointly as far as possible. The report brought out an extended discussion, the general trend of which was that while co-operation was favored, there were serious objections to any action which might terminate in an actual combination of the two organizations.

On Thursday the subject of profit sharing was discussed, and several sets of resolutions were passed relating to industrial questions. Approval was expressed of a foundry school recently established at Indianapolis under the direction of the National Founders Association, and extended resolutions were passed relating to the bill now before Congress looking to the adoption of the metric system in government work. The resolutions strongly opposed this, stating that the Metal Trades Association as a body, and also its individual members, objected to the adoption of the metric system as the one legal standard of weights and measures. In the various resolutions passed and in the discussions a sentiment of fairness toward labor and labor organizations existed, but with it a determination to hold firmly to right industrial principles.

The officers elected for the ensuing year are as follows; President, W. D. Sayle, Cleveland Punch & Shear Works, Cleveland, Ohio; First Vice-President, M. H. Barker, American Tool & Machine Co., Boston, Mass.; Second Vice-President, F. K. Copeland, Sullivan Machinery Co., Chicago, Ill.; Treasurer, William Lodge, The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

On Wednesday evening there was a dinner given by the manufacturers of Cleveland at the Hollenden; and following the dinner were the usual speeches by several prominent people.

* * *

Announcement is made of the purchase from the Industrial Press, publishers of MACHINERY, of the Mechanical Index, by the Donnell-Colvin Co., 256 Broadway, New York. Mr. Donnell was for eleven years with the Hill Publishing Co., engaged in various capacities upon the *Amercan Machinist* and *Power*. Mr. Colvin was the first editor of MACHINERY, and later was with *Locomotive Engineering* in both editorial and business capacities. The members of the Donnell-Colvin Co. are therefore well equipped to take up the publishing and distributing of an important work of the character of the Mechanical Index. They know the mechanical field thoroughly, are in constant touch with it through the Derry-Collard Co., publishers and book sellers, with whom they are associated, and under their management the Index should become invaluable to every person wishing to reach the mechanical trade. The volume as it now stands comprises over nine hundred pages of manufacturers of machinery and mechanical devices, all carefully classified and indexed for convenient reference, and is the best directory in its field. It is the purpose of the Donnell-Colvin Co. to keep this list strictly up to date, to add to it from time to time as mechanical development requires, and to maintain it as a complete and thoroughly reliable directory of manufacturers of machinery, tools and allied apparatus.

* * *

The Cincinnati Lathe & Tool Co., of Cincinnati, Ohio, which has recently been incorporated for the purpose of manufacturing lathes and other machine tools, has purchased the lathe business of the Fosdick Machine Tool Co., of the same city. Their specialty is a sixteen-inch lathe equipped with the well-known feed device patented by W. T. Emmes. The president of the new concern, Mr. W. C. Heindel, has been connected with the Cincinnati Milling Machine Co. for ten years past; while Mr. A. B. Sowden, the superintendent, has been building lathes for twenty years. The shops of the concern are located in the heart of the machine tool district of the city. They are being equipped with new high-grade machinery, and will be in running order by April 1st, 1906. The company is now in a position to book orders for future deliveries, which will be given their most careful attention.

* * *

The National Machine Tool Builders' Association will hold their spring convention at Atlantic City on May 1 and 2. The headquarters will be at the Chalfonte Hotel. In the call for the meeting, the secretary states that there is a manifest feeling that this convention should be strictly for business to give ample opportunity for the several committees to confer and discuss such matters as are pertinent to their peculiar subjects, and later report to the full convention.

* * *

The inside flange of channel and I-beams has a rise of 2 inches per foot, or angle of about 9½ degrees with the base.

MACHINERY.

May, 1906.

SECTIONS OF CAST IRON BEAMS.

C. H. BENJAMIN

During the winter of 1901-02 interesting experiments were carried on at the laboratories of the Case School by senior students A. F. Kwis and R. H. West. The object of these experiments was to determine the relative strength and stiffness of cast-iron beams having cross-sections of the same area but of different shapes.

The results have never been published and seem to the writer of sufficient interest to the designer of machinery to warrant their presentation.

Since it was necessary to eliminate all variables except the ones to be compared, great pains were taken with the casting of the test bars. The patterns were all twenty inches long and had the same cross-section of 4.15 square inches. As may be seen from the tables the areas of the cast beams varied slightly. The castings of each set were all made from the same ladle of iron and were cast on end. A soft gray iron was used and a large flush basin distributed the molten metal to the mold, giving a uniform temperature and quality. Acknowledgments should be made to Mr. Thos D. West for his assistance in the preparation of the castings, which were remarkably uniform in texture and quality.

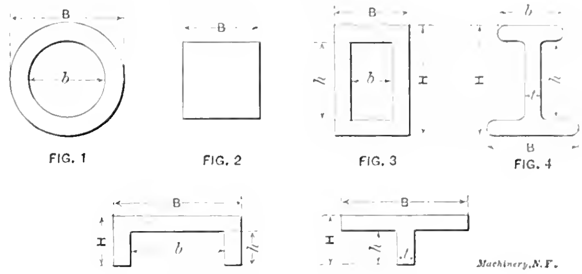
The specimens were all tested by loading transversely at the center, the supports being 18 inches apart.

Object.—The investigation had two distinct objects in view and two classes of test pieces were used. The first class comprised Nos. 1 to 11 and Nos. 22 to 32 and these specimens had sections such as are used in parts of machines.

The second class comprised Nos. 12 to 21 and 33 to 42, all having sections similar to those used in the rims of fly wheels. The object of this part of the investigation was to determine the influence of flanges on either the tension or compression sides of the sections.

Sections.—The sections of the beams in the first class were as follows: Solid circular, solid square, solid rectangular, hollow circular, hollow elliptical, hollow rectangular, I-sections with flanges of various proportions.

The illustrations show the general outlines and have letters on them referring to the dimensions given in the tables. The values of $\frac{I}{y}$, the section modulus, refers to the fiber in tension as do also the values for fiber stress.



Key to Dimensions of Sections Tested.

The dimensions given in the table are those of the pattern, while the areas are those of the specimens at the point of rupture. There are two specimens of each shape cast from the same pattern.

Experiments.—The section modulus $\frac{I}{y}$ was calculated from the dimensions of the casting at the breaking point. In testing each specimen the load was applied gradually and readings of the deflection were taken at regular intervals. When the "set" load was reached, the pressure was removed and a reading of the permanent set was taken. The load was again applied and observations made on the deflection up to near the time of rupture.

The load-deflection curves plotted from these observations are nearly all smooth and uniform in character, as may be seen by reference to Fig. 7 which shows the curves for No. 33.

The initial line curves gradually from the start showing an imperfect elasticity, while the set line is nearly straight and approximately parallel to the tangent of the curve at the ver-

TABLE 1.

No.	Section		Dimensions.					Section Modulus $= \frac{I}{y}$	Loads in Pounds			Set in Inches.	Fiber Stress.	Modulus of Elasticity.
	Shape.	Area.	B	b	H	h	t		Breaking	When $\Delta = .03$	Set.			
1		4.40	2.3	......	......	......	......	1.304	7,500	2,500	5 000	.018.	25,900	8,280,000
22		4.45	......	......	......	......	......	1.321	7,250	2,600	5,000	.020	24 640	8,290,000
2		4.46	2.04	......	......	......	......	1.565	8,100	2,600	5,000	.016	23 300	8,650,000
23		4.41	......	......	......	......	......	1.513	8,150	3,700	5,000	.005	23,600	9,850,000
3		4.50	1.04	......	1.02	......	......	3.05	15,200	7,500	15,000	.0225	22 300	6,690,000
24		4.67	......	......	......	......	......	3.19	17,100	8,000	15,000	.0195	24,120	6 530,000
4		4.43	3.4	2.5	......	......	......	2.878	16,900	7,000	15,000	.020	26,450	6,660,000
25		4.37	......	......	......	......	......	2.880	22,900	7,500	15,000	.018	35,800	7,440,000
5		4.20	3.81	3.01	......	......	......	3.27	20,100	7,500	15,000	.0205	27,700	5,360,000
26		4.52	......	......	......	......	......	3.494	22,700	7,000	15 000	.019	29,200	5,860,000
6		4.36	3.	2.1	3.9	3.05	......	3.175	25,400	6,500	20 000	.010	36,000	6,190,000
27		4.47	......	......	......	......	......	3.27	25,100	......	....		34 600	....

tex. The so-called moduli of elasticity were calculated from the set lines using the formula

$$E = \frac{W l^3}{48 \Delta I}$$

In each test a reading of the load was taken at the instant when the deflection measured 0.03 inch, and these loads may be taken as a fair measure of the "stiffness" of the section.

Calculations.—The fiber stress was calculated from the breaking load and the section modulus, using the formula:

$$S = \frac{M y}{I} = \frac{W l y}{4 I}$$

section, from a minimum of 18,700 to a maximum of 36,000, show that the ordinary method of calculation would not be of much value in predicting the breaking load of such beams.

Comparison of Strength.—An investigation of the values in Table I. shows that the hollow circular and elliptic sections are much stronger than the solid sections, the increase in strength being greater than that of the section modulus. The average value of S for the last six numbers in Table I. is 31,600 as against 24,000 for the six solid sections, an apparent increase in the strength of the material itself of over 25 per cent. This is partly due to the thinner metal, the greater surface of hard "skin" and the freedom from shrinkage strains.

TABLE II.

No	Section.		Dimensions					Section Modulus	Loads in Pounds.			Set in Inches.	Fiber Stress.	Modulus of Elasticity.
	Shape.	Area	B	b	H	h	t	$\frac{I}{y}$	Breaking	When $\Delta = .03$	Set.			
7		4.36	3.09	2.53	4.0	3.25	....	5.08	24,250	9,000	20,000	.020	21,500	3,290,000
28		4.40	....	....	....	....	....	5.14	32,100	12,000	20,000	.011	28,180	5,530,000
8		4.25	3.22	3.22	4.0	3.1	.437	5.94	22,250	8,000	20,000	.018	17,700	3,750,000
29		4.88	....	....	....	....	....	5.61	26,250	12,500	20,000	.010	21,100	5,340,000
9		4.87	4.22	2.5	4.0	3.25	.50	6.36	29,950	11,000	20,000	.015	21,220	5,760,000
30		4.81	....	....	....	....	....	6.56	33,150	13,000	20,000	.012	22,800	5,480,000
10		4.70	4.22	2.22	4.0	3.15	.375	6.49	32,400	12,000	20,000	.013	22,500	5,380,000
31		4.53	....	....	....	....	....	6.56	31,100	9,000	20,000	.015	21,380	4,040,000
11		4.63	3.70	2.70	4.0	3.15	.437	6.42	31,200	9,500	20,000	.019	21,900	4,630,000
32		5.12	....	....	....	....	....	6.53	38,050	13,300	20,000	.007	26,220	5,050,000

TABLE III.

No.	Section.		Dimensions.					Section Modulus	Loads in Pounds.			Set in inches.	Fiber Stress	Modulus of Elasticity.
	Shape.	Area.	B	b	H	h	t	$\frac{I}{y}$	Breaking	When $\Delta = .03$	Set.			
12		4.51	4	2.5	1.5	.75	....	.81	5,400	2,100	4,000	.012	30,000	10 740,000
33		5.10	4	2.5	1.5	.75	....	1.99	8,350	2.400	6,000	.024	18 900	8,570,000
13		4.48	4	....	1.5	.75	1.5	.799	5 200	2,000	4,000	.013	29,300	8,430,000
34		4.67	4	....	1.5	.75	1.5	1.68	7,000	2,000	6,000	.041	18,700	8,610,000
14		4.61	5	4.	1.62	1.	....	.692	4,700	1.750	4.000	.017	30,580	10,170,000
35		4.80	5	4.	1.62	1.	....	1.61	8 800	2,400	6,000	.024	24,600	11,060,000
15		4.48	5	....	1.62	1.	1.	.731	4,200	2,000	4.000	.002	25,850	10,250,000
36		5.38	5	....	1.62	1.	1.	1.74	9,450	2 500	5,000	.016	24,750	10,550,000
16		4.23	4	....	1 87	1.12	1.	.802	4,300	2,500	4,000	.017	24,100	9,350,000
37		4.82	4	....	1.87	1.12	1.	1.795	9,500	3,000	8,000	.040	23,800	10,740,000

As before noted the values of S and $\frac{I}{y}$ refer to the under or tension side of the beam. The modulus of rupture, as S is generally called, is supposed to represent the tensile stress on the outer fibers at the point of rupture and to measure in a way the transverse strength of the material. In the absence of a better measure we will use this, and take the circular and square sections as our standards. The average value of S for the four is 24,360 pounds per square inch.

This is a low value even for soft gray iron. The remarkable fluctuations in the value of S for specimens of different cross-

The absence of corners and the consequent uniformity of metal make this an ideal form of section.

The hollow rectangles and the I-sections given in Table II. have an average value of $S = 22,450$.

No. 8 is lower than the average and Nos. 28 and 32 considerably higher. These discrepancies are due to some accidental condition of the metal, since the mates of these pieces had about the average strength.

The relatively low values of S for this series are probably due to cooling strains in the metal. The table shows quite conclusively that the increase in strength in such section is not proportional to the increase in the section modulus.

Elasticity.—The values for the modulus of elasticity in Tables I. and II. seem almost ridiculous, if we are to regard this much abused "constant" as any criterion of the stiffness of a beam.

According to the results of tensile and transverse tests on cast iron E is a variable, being greatest for small loads and diminishing as we approach the breaking load.

Prof. Lanza gives values varying from nine to eighteen millions for a test on one bar. As has been explained the values of E were determined from the set lines which were approximately straight and not subject to the variation above mentioned. Examining the tables we find the values of E ranging all the way from 11,000,000 down to 3,290,000.

The larger values go with the smaller depths as in Nos. 17 and 38 and the smaller values are found in the sections having the largest section moduli as in Nos. 7 to 11.

This goes to show that the common formula for E does not apply well in the case of cast-iron sections and that the deflection of hollow and I-shaped sections is much greater than would be given by the formula. The columns giving the loads for a deflection of 0.03 inch illustrate this. For instance the values of I for Nos. 1 and 32 are 1.545 and 12.67 respectively, having a ratio of 8.2.

The loads required to produce the same deflection of 0.03 inch are 2,500 pounds and 13,300 pounds respectively, having a ratio of only 5.3.

Rim Sections.—The object of the experiments summarized in Tables III. and IV. was to determine the effect of flanges on the strength and stiffness of sections such as are used for the rims of fly wheels.

In order to illustrate this more clearly each alternate section was turned over so as to bring the flanges on the tension side, as may be seen by the shapes in the second columns of the tables.

The section modulus and the fiber stress was always calculated from the tension side.

In nearly every instance the calculated fiber stress is higher for the beam having the web in compression and the flanges in tension, or in other words there is not so much disadvantage in this latter arrangement as theory would indicate.

For instance, the section modulus for No. 31 is more than twice that of No. 13 of similar shape and area, but the breaking load is only one third greater. If we knew where the neutral axes of these sections really were during the process of bending we might perhaps explain this discrepancy.

Depth of Flanges.—Another object of these experiments on wheel rim sections was to determine the relative value of shallow and deep flanges. The average value of the breaking load for the ten sections with shallow flanges in Table III. is 6,690 pounds, and the average fiber stress about 25,000 pounds per square inch. The corresponding values for the ten sections with deeper flanges in Table IV. are 11,800 and 22,800. There is thus a slight falling off in the fiber stress for the deeper sections but not so much as was noticed in the two other tables.

The elasticity of these sections is more uniform than in those previously noticed, E varying from six to eleven millions. We notice, however, the same peculiarity as before, that the deeper sections are not so stiff in proportion to the values of I as those having shallow flanges.

The conclusions to be derived from these experiments can be stated in a few words:

TABLE IV.

No.	Section.		Dimensions.					Section Modulus $= \frac{I}{y}$	Loads in Pounds.			Set in Inches.	Fiber Stress.	Modulus of Elasticity.
	Shape.	Area.	B	b	H	h	t		Breaking	When $\triangle = .03$	Set.			
17		4.45	3.75	....	1.94	1.56	1.78	1.404	7,650	3,500	5 000	.011	24,500	10,220,000
38		5.20	3.75	....	1.94	1.56	1.78	2.14	10,900	4 250	6,000	.009	22,950	11,070,000
18		4.25	4.	....	2.25	1.5	.75	.914	5,250	3,000	5,000	.018	25,900	9,060,000
39		4.60	4.	....	2.25	1.5	.75	2.88	12,000	3 750	8,000	.022	18 700	10,750,000
19		4.41	5.	....	2.25	1.62	.625	.835	4,400	7,250	....	....	23,700	....
40		4.60	5.	....	2.25	1.62	.625	2.30	12,250	3 750	10,000	.037	24 000	9 340,000
20		4 47	4.	....	3.25	2.62	.625	1.774	7,900	5,500	6,000	.007	20,050	7,100,000
41		5.02	4.	....	3.25	2.62	.625	4.36	22 600	8 000	20,000	.034	23,250	7,880,000
21		4.50	5.	....	3.75	3.25	.5	1.784	10,200	7,250	10,000	.011	25,800	6,230,000
42		5.18	5.	....	3.75	3.25	.5	5.95	25 000	9,250	20 000	.020	18,900	7,280,000

(1) The commonly accepted formulas for the strength and stiffness of beams do not apply well to cored and ribbed sections of cast iron.

(2) Neither the strength nor the stiffness of a section increases in proportion to the increase in the section modulus or the moment of inertia.

(3) The best way to determine these qualities for a cast iron beam is by experiment with the particular section desired and not by reasoning from any other section.

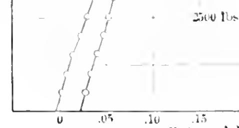


Fig. 7. Load Deflection Curves for Sample No. 33.

The experiments described in this article were made with unusual care on a remarkably clean and homogeneous iron and the regularity of the load curves shows accurate measurement.

That the calculated stresses and moduli show so wide a divergence must be attributed to the formulas rather than the work.

A set of preliminary experiments made on similar sections in 1901 gave results almost identical with those described, the values of S ranging from 22,000 to 35,000 and those of E from five to nine millions for a rather hard gray iron. The hollow circular sections made the best showing and the thin, deep I-sections the poorest.

* * *

About the hardest material to remove from metallic surfaces is paint burned onto the front ends and cylinders of locomotives. The long-continued baking process to which numerous coats of black paint are subjected converts it into a substance almost as hard as the iron itself. Sand blast quickly removes the paint on ordinary iron surfaces, but on the front ends it takes from three to four times as long to clear the surfaces of the hardened scale.

VIEWS OF THE HOMESTEAD (PA.) CLUB HOUSE.

In view of the increasing number of club rooms and club houses that are now being provided by the managements of industrial plants to contribute to the comfort and welfare of their employees, the accompanying views of one of the three largest and finest club houses erected for this purpose in this country will be of interest. These views are of the house of the Homestead Club built by Andrew Carnegie for the steel workers at the Homestead plant. Similar structures were later erected at Braddock and Duquesne, the three being, as stated, the largest and finest buildings of the kind in the country. The board of directors of the Homestead Club is composed of the superintendent of the works, three other employees, and three townsmen.

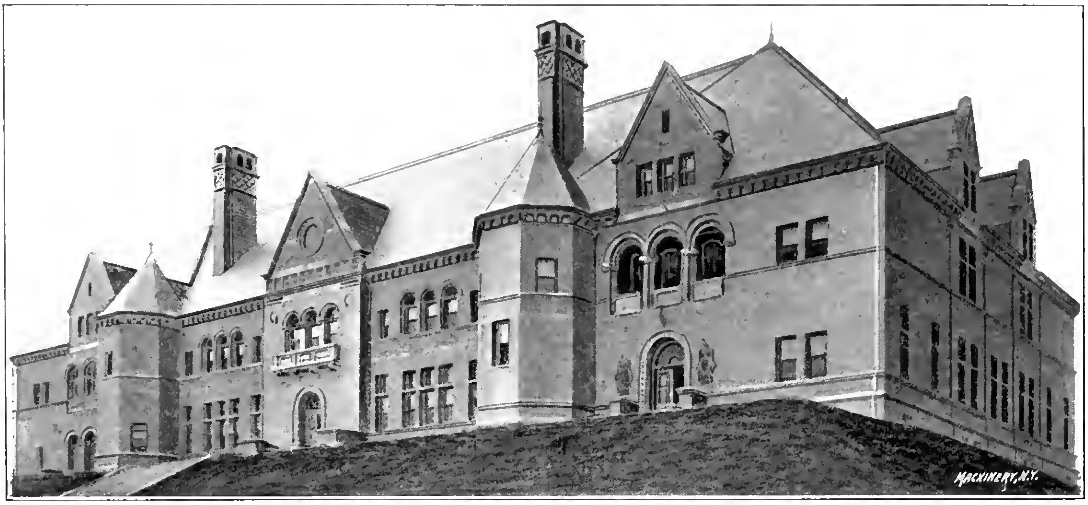


Fig. 1. Club House built by Andrew Carnegie for the Steel Workers of Homestead.

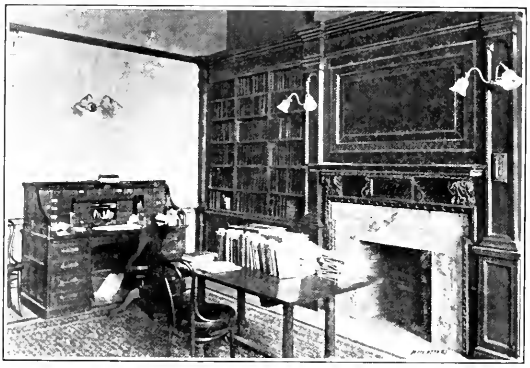


Fig. 2. A Corner of the Library.

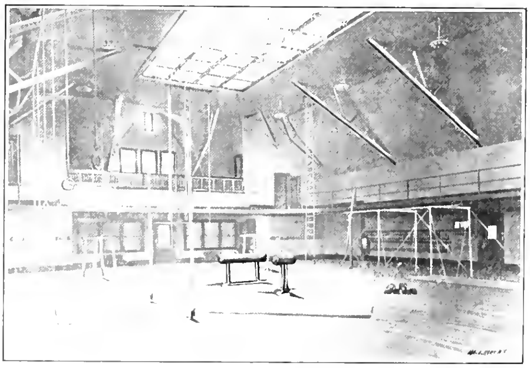


Fig. 3. The Gymnasium.

There is a free public library, open to all residents of Homestead who receive recommendations from the superintendent if they are unknown to the librarian. The day employees of the steel works patronize the library evenings, and when the men work night turns they utilize it afternoons. Connected with the library is a children's reading room. Rooms are provided for evening classes in arithmetic, mechanical drawing, chemistry, metallurgy, several languages, and stenography.

An auditorium, called Music Hall, contains a large pipe organ donated by Mr. Carnegie. Concerts, lecture courses, and theatricals are given there. The seating capacity is 1,142, and it is quite usual to be obliged to turn away as many who desire to attend the entertainments as those who participate. There is a regular entertainment course for which one dollar is charged for season tickets. There are other amusements which are free to club members, notably the organ recitals, held every two weeks.

Among other features of the building are a band room in which 35 members of the steel works band may practice; a lounging and smoking room furnished with beautiful rugs, leather couches and chairs, and containing, also, a cigar stand; a card room with six game tables; a billiard room with nine tables, where many of the employees have developed into skillful billiard players; a bowling alley; a room arranged for the wives and daughters of employees, called the Women's Parlor, where there are a pool table, a piano and card tables.

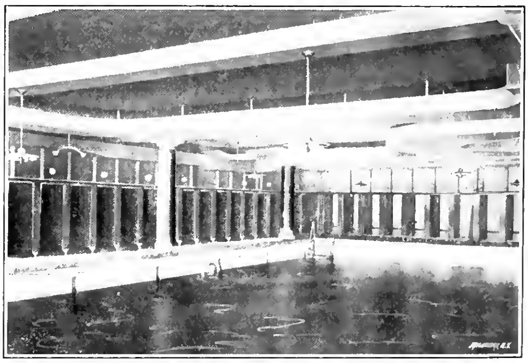


Fig. 4. Swimming Pool in the Basement.

Two of the most important departments of the building are the gymnasium and the swimming pool.

The gymnasium is equipped with substantial, scientific apparatus, and there is a competent physical director in charge. Separate classes are arranged for men, women, boys,

and girls. After each class the gymnasium floor is cleared for basket ball, indoor base ball, or other games.

The swimming pool in the basement is well patronized by the laboring men. Monday and Friday afternoons, from four to six o'clock, the women are allowed the use of the swimming pool, and there are special times arranged for the boys, so that they do not interfere with the enjoyment of the large crowd of men who are able to attend only after working hours. There are also in the basement eighteen tub baths and four shower baths, as well as toilet arrangements, for the men. The women have a dressing room with four baths.

While the library is for the free use of the citizens of Homestead, only club members may enjoy the other privileges of the building. The dues are:

	Three Months.	One Year.
Carnegie employees	$1.50	$4.00
Non-employees	2.00	6.00
Women	1.00	4.00
Boys and girls under 18......	.50	2.00

* * *

Under the title "The Conditions of Fan-Blower Design" Walter B. Snow in *Cassier's Magazine* for January, states that "in the design of a wheel to meet given requirements, it is necessary to make its peripheral speed such as to create the desired pressure, and then so proportion its width as to provide for the required air volume. Evidently the velocity and corresponding pressure may be obtained either with a small wheel running at high speed, or a large wheel running at low speed. But if the diameter of the wheel be made too small, it may be impossible to adopt a width, within reasonable limits, which will permit of the passage of the necessary amount of air under the desired pressure. Under this condition it will be necessary to run the fan at higher speed in order to obtain the desired volume. But this results in raising the pressure above that desired, and in unnecessarily increasing the power required. On the other hand, if the wheel be made of excessive diameter, it will become almost impracticable on account of its narrowness. Between these two extremes a diameter must be intelligently adopted that will give the best proportions. In practice the width of a ventilating fan seldom exceeds one-half its diameter. In a fan for high pressures the proportion may run as low as one to twenty."

PATENTS IN THEIR RELATION TO THE GAS ENGINE AND THE AUTOMOBILE.—3.

S. M. HOWELL.

By an oversight of the author in the first article of this series the Robson patent of 1881 was shown as the first example of a two-cycle engine working a compressed charge. There was, however, an earlier construction; namely, the Dugald Clerk English patent of August 1, 1878. A United States patent on this invention was also taken out by Mr. Clerk on July 27, 1880, No. 230,470. This patent is therefore entitled to priority over that of Robson. Mr. Clerk's engine received an impulse at each revolution of the shaft, and he incidentally alludes to this feature in his specifications. The ignition was effected by means of a bundle or roll of sheet platinum placed in a pocket connecting with the cylinder by means of a timing valve. The platinum was maintained at an incandescent temperature partly by the heat of the explosions.

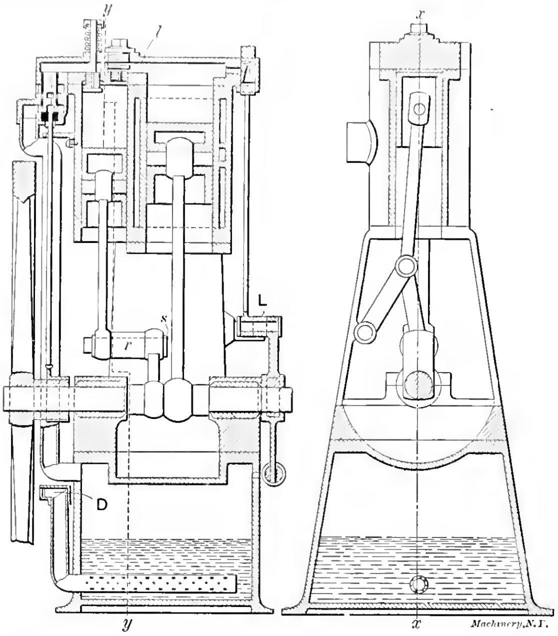
The well-known hot-tube system of ignition is a development of this incandescent platinum method, having been applied by Daimler and others. The device originated, however, at a much earlier date than that of the Clerk patent; having first appeared in a gas engine patent granted to Stewart Perry of October 7, 1846, No. 4,800.

Fig. 5. Music Hall, an Auditorium in the Club House, which Seats about 1200.

This old-time experimenter also claims in this patent to be the original inventor of the water-jacketed cylinder; also of the injection of small quantities of water into the cylinder to assist the lubrication of the piston; of the auxiliary reservoir of compressed air for starting the engine; and of a liquid fuel vaporizer heated by the jacket water, including a very simple and effective device by which the proper supply of the liquid fuel is automatically controlled. This venerable inventor used turpentine for fuel, but on account of the high price of the article and the extravagant manner in which his engine consumed it, the old gentleman probably gave up in despair and abandoned his engine as a vain device. The Dugald Clerk engine forced a charge of air and gas into the cylinder at each revolution by means of a pump or separate charging cylinder, a system of construction which was subsequently followed by Riher, Beechy, Sintz and others. The Sintz patent of 1886 is fairly representative of this class, and is shown in Figs. 1 and 2. The small cylinder seen on the left in Fig. 1 is the pump

or charger which delivers a charge of carbureted air to the power cylinder at each revolution. In the base of the engine may be seen a form of the familiar surface carbureter. The system upon which this class of engine is constructed is not often adopted by modern designers, especially when the object is to secure an engine of few parts suitable for high speeds; but the system is nevertheless capable of successful application and might be used to advantage in some cases.

The compound gas engine of G. W. Daimler, patented December 9, 1879, No. 222,467, is shown in Figs. 3 and 4. This engine had two initial explosion or high-pressure cylinders which operated on the four-cycle principle and alternately delivered their exhaust gases to a third cylinder of larger size located between the other two; in this way securing two impulses at each revolution, and thus constituting a double-acting high-



Figs. 1 and 2. The Sintz Gas Engine, with Auxiliary Compression Cylinder.

compression compound gas engine, and moreover one in which the reciprocating parts are in balance. The high-pressure pistons, connecting rods and cranks are together just equal in weight to the corresponding parts of the low-pressure engine. The high-pressure cranks are in line with each other and diametrically opposite the low-pressure crank, so the opposing forces are in perfect mechanical balance and the engine will therefore run at any speed without vibration.

Another patent, Fig. 5, is that of L. H. Nash, May 22, 1883. This patent has expired and is useful as a precedent for the principle of operation known as continuous combustion. In this system the gas and air are first compressed to a high degree by separate pumps and delivered to the power cylinder as shown, during either a part or all of the power stroke. There is no explosion, but merely a continuous burning of the gas as it enters the cylinder, and by the heat of which a small amount of air is enormously expanded and the original pressure maintained.

Fig. 6 shows the cylinder and piston of a two-cycle engine which is said to have originated in England some years ago, and is known as the Loyal motor. It is probably the simplest form of reciprocating gas engine. The piston receives an impulse at each revolution of the shaft, and the engine automatically exhausts, inspires and strongly compresses a new charge in an open-ended cylinder without either mechanically-operated valves or an enclosed crank case, and without

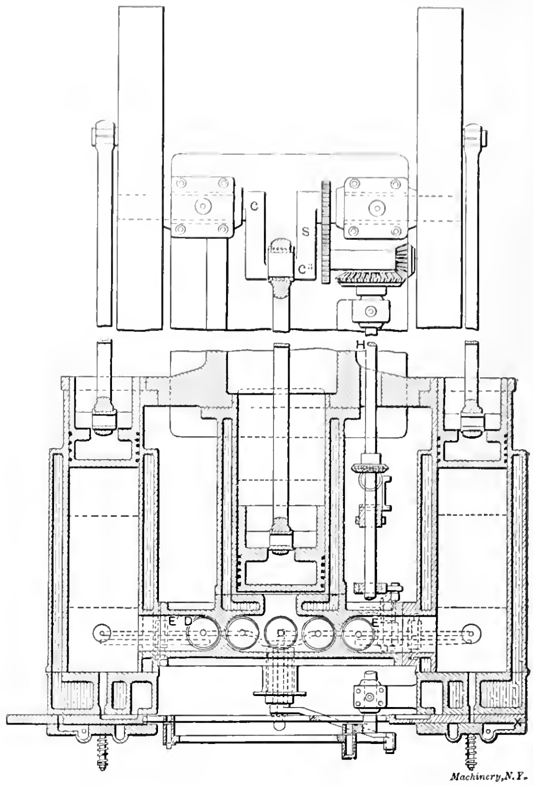


Fig. 3. Cross-section of the Daimler Compound Engine.

preliminary compression. It is, in fact, a veritable wonder. In the figure, *a* is the piston, *b* the inlet valve, and *c* the exhaust port. This port includes a self-acting valve not shown in the drawing, but which is similar to the inlet valve except that it opens outwardly.

The operation is as follows: Suppose the piston to have reached the limit of its instroke, indicated by the dotted line *d*. The charge is then fired and the piston goes forward on the power stroke, passing and uncovering the exhaust port through which the spent charge passes, forcing open the exhaust valve and escaping to the atmosphere. As the piston proceeds, a partial vacuum is formed behind it, opening the inlet valve and admitting a fresh charge. When the piston has arrived at the end of the power stroke, as shown in the drawing, and starts to return, the exhaust valve again opens and discharges

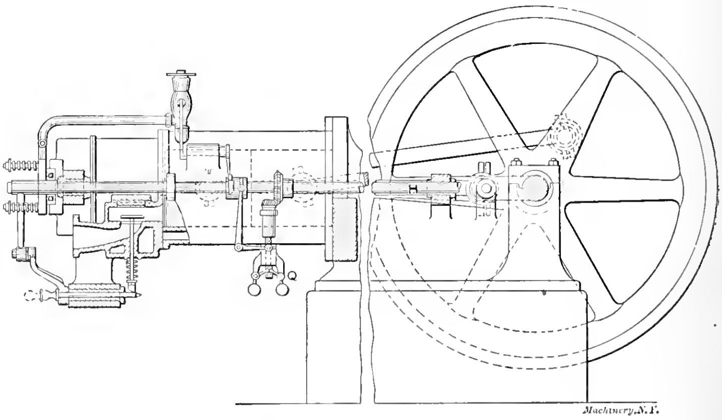


Fig. 4. Elevation of the Daimler Gas Engine.

the remaining portion of the burnt charge until the closure of the exhaust port, the piston continuing its inward motion and compressing the fresh charge to the termination of the instroke, ready for another power impulse, and so on in continuous operation.

This system is subject to several modifications and has frequently been designed without valves, the admission and exhaust being effected by piston-operated ports. An engine of this kind has been used to propel an automobile, but its inherent defect is the fact that the exhaust must take place at a time when the piston is moving at its most rapid rate. The system is therefore not suited to high speeds.

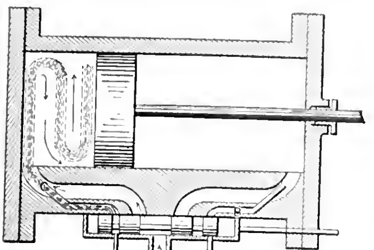


Fig. 5. Nasn Continuous Combustion Engine.

Fig. 7 shows a method of constructing a four-cycle double cylinder engine in which the cylinders are placed on diametrically opposite sides of the shaft and in the same axial center line; by this arrangement the reciprocating parts are to a certain extent in equilibrium, but the balance is of course not complete. This system of construction is very successfully used, however, by at least one firm in this country.

In the last paper we referred to the Nash two-cycle engine patent of July 17, 1888, No. 386,211, as here shown. The original application for this patent was filed November 5, 1885, but withheld from issue by the inventor for nearly three years, and kept alive by annual renewals. This was presumably for the purpose of extending the life of the patent or of postponing its appearance until the arrival of a more favorable time; somewhat after the far-seeing manner of that famous automobile inventor, Mr. George B. Selden.

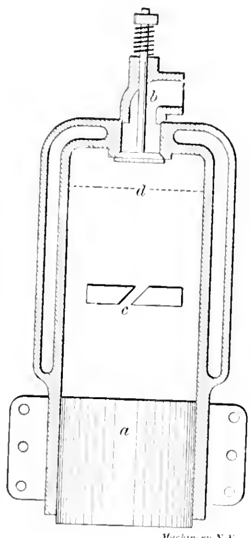


Fig. 6. The "Loyal" Motor.

This Nash patent contains six claims which are devoted exclusively to the construction of the piston deflector and a co-acting part of the combustion chamber, by means of which the entering charge is so directed and conducted as to force out the burnt gases of the previous explosion without mixing therewith. In regard to the enclosed crank case, the inventor terms this the compression chamber, and merely refers to the same as a cheap and simple method of construction; notwithstanding this fact, however, this patent is apparently the first instance of a two-cycle engine constructed with an enclosed crank case for the purpose of preliminary compression. The inventor's reason for not including the same in his claims doubtless was that a similar construction had been previously claimed by him in his four-cycle engine patent of 1883, No. 289,019, illustrated in our first paper.

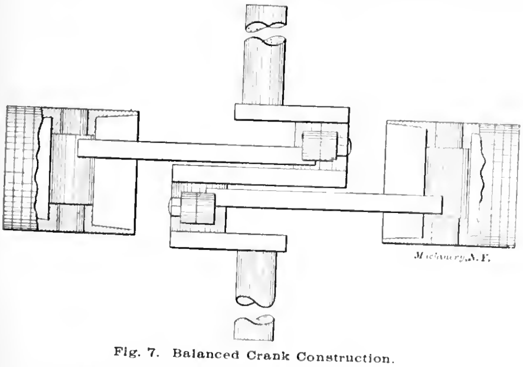


Fig. 7. Balanced Crank Construction.

In the case we are now considering the drawings show three modifications of the piston deflector and combustion chamber arrangements. Figs 8 and 9 show the first form of construction. Fig. 10 is a cross-section taken on line *x x* of Fig. 8. Fig. 11 represents the second form of construction. Fig. 12 is a cross-section of Fig. 11, on line *y y*. Fig. 13 is a cross-section of Fig. 11, on line *z z*. Fig. 14 shows the third method of constructing the combustion chamber and piston deflector. Fig. 15 is a cross-section of Fig. 14. These drawings are sufficiently clear to be self-explanatory and a detailed description is therefore unnecessary here.

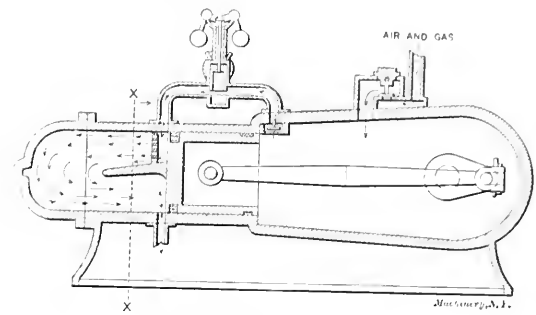


Fig. 8. The Nash Two-cycle Engine.

Regarding the relative merits of the three modifications, the inventor says that for small engines either of the two forms first shown are suitable, but in large engines the heat of the burning charge is too great to admit of the use of these means, and therefore in engines of large size the last-named modification is preferable.

In the conception of this invention it is a remarkable fact and seems to be an instance of strange oversight that Mr. Nash constructed his engine with the cylinder admission and exhaust ports on the same diametrical line, to be opened simultaneously at the last part of the power stroke, depending on a check valve in the transfer passage to prevent the exhaust from entering the crank case and back firing the new charge. Had the cylinder of this engine been constructed with the exhaust port in advance of the cylinder inlet port in the direction of the piston travel on the outstroke, thus permitting the exhaust to escape prior to the uncovering of the cylinder inlet port, the inventor would have produced a better engine and completely anticipated a strong point in subsequent inventions; but regrets are in vain.

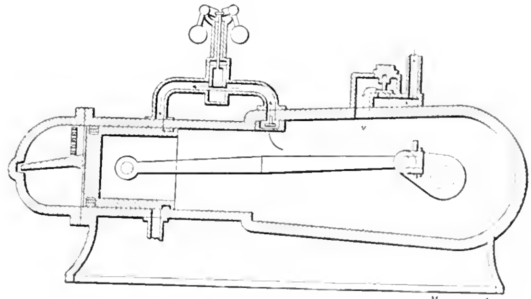


Fig. 9. Section of Nash Engine, Piston at Inner End of Stroke.

The above description completes the list of five patents named in former papers as furnishing the elements from which modern two-cycle engines are designed. The two-cycle engines best suited to the requirements of automobile service, however, are constructed upon what is known as the three-port system. In this system there is a crank-case inlet port so situated as to be uncovered by the outer end of the piston toward the end of the instroke and for a corresponding length of time at the beginning of the following outstroke. The exhaust and cylinder inlet ports are so located relative to each other that the exhaust will open first; the absence of the latter feature constituting the deficiency of the Nash patent already referred to. Patent law questions regarding the three-ported engine are

therefore limited to the ground covered by the Sintz, Day and Cock patents. The location of the exhaust port in advance of the cylinder inlet is shown in all four of the patents named, but is claimed only by Sintz. It is true that the English patents of Day and Cock are prior to that of Sintz, but I am informed by Mr. James Whitmore, of Detroit, Mich., that the

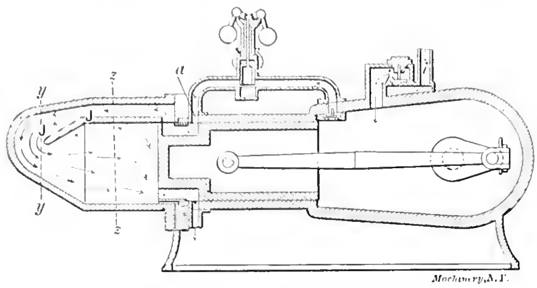


Fig. 11. A Modification in which the Piston acts as a Valve.

issue of the Sintz patent was preceded by an actiou in which Sintz proved his priority to Day. This fact would therefore place the advance exhaust port under tribute to the Sintz patent, but it must be admitted that the Sintz claim of this feature is only inferentially stated and is not so definite and emphatic as its importance would seem to warrant.

In regard to the crank-case inlet port named above, this feature is contended only in the Sintz and Cock patents, which, however, contain the said port in different forms. But as the Cock patent is based upon an English issue which preceded the Sintz application, the Cock patent therefore controls this feature, and while the three-ported engine is subject to the limitations of both the Sintz and Cock patents the claim for it in the Cock patent is weakened by the so-called dual or double arrangement of separate gas and air inlets. The Day patents have become non-effectual, owing to the expiration of the English patents, and the Cock patent will expire on October 15, 1906, for a similar reason. The Sintz patent will expire on Nov. 21, 1910.

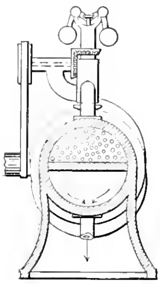


FIG. 10

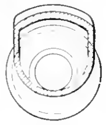


FIG. 12

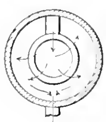


FIG. 13

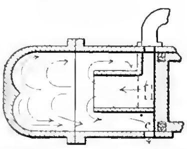


FIG. 14

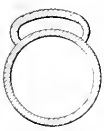


FIG. 15

Cross-sections of Figs. 9 and 11.

The law mentioned in the first paper of this series to the effect that the grant of a United States patent is void, if based on an application filed more than twelve months after the filing of a foreign application, was not in force when the Day and Cock applications were pending.

* * *

The development of the automobile has produced a power plant, capable of generating, say, 50 horse power, that can almost be packed away in a good-sized Saratoga trunk, but the cost of the fuel—gasoline—is practically prohibitive for almost all commercial vehicles. The rapidly increasing consumption and the fact that the newer oil fields are not producing oils rich in the lighter products such as gasoline, do not promise any cheapening in price but much rather a material advance. The alternatives are alcohol free of government tax and the portable gas producer plant. What is needed in the latter is a producer that shall be light, safe and reliable with the minimum of skilled attendance. There is already a big field open for the portable producer on motor boats where the question of weight is not so important as on the automobile. The ultimate development of the railway motor car will also require the gas producer.

THE PROBLEM OF TOUCHING CIRCLES.

A. L. DE LEEUW.

In the issue of March, 1906, I notice in the "How and Why" column, a statement by the editor, to the effect that no accurate and simple solution has been proposed for the problem of describing a circle which shall touch three given circles. I hate to "butt in," but can't help saying that, to the best of my knowledge, this very solution was proposed some 2,500 years ago. I wasn't there myself, and, therefore, cannot vouch for the exact date; but I remember having read a good description of it when I was a boy, which is several years ago though not quite 2,500. The trouble with this problem is not so much that it is a difficult one, as that it depends on the solution of another problem, and this again on the solution of still another. All of these problems are simple enough taken separately; but one has to go through the whole series, to come to a simple solution of your problem in No. 14.

The following three problems must be solved:

No. 1. To describe a circle, which shall touch a given circle, and go through two given points.

No. 2. To describe a circle which shall touch two given circles, and go through one given point.

No. 3. To describe a circle which shall touch three given circles.

For problem No. 1 see Fig. 1, in which A is the center of the given circle; O is the center of the circle to be described;

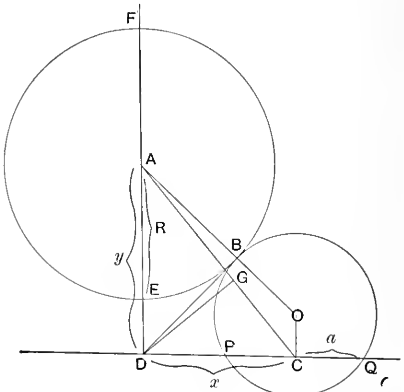


Fig. 1.

B is their point of contact; P and Q are the points through which the circle to be described must go. In order to analyze this problem, the diagram is drawn as if the circle to be described were already found. The line QP is drawn until it intersects the common tangent BD of the two circles. From this point D a line is drawn to the center A of the given circle. This line intersects this circle in the points E and F.

As is well known to all who have ever studied geometry,

$$DP \times DQ = \overline{DB}^2$$

Similarly

$$DE \times DF = \overline{DB}^2$$

so that

$$DP \times DQ = DE \times DF$$

C is the center of line PQ. The length from this point to D is called x. The length of cord PQ is called $2a$, so that $DP = x - a$, and $DQ = x + a$. The radius of the given circle is called R; and the distance from D to A is called y; so that $DE = y - R$ and $DF = y + R$. Substituting these values in the equation found above, we have:

$$x^2 - a^2 = y^2 - R^2$$

or

$$y^2 - x^2 = R^2 - a^2.$$

Drawing the line AC and the perpendicular to that line at point D, we also know that $x^2 - CG^2 = y^2 - AG^2$

or

$$AG^2 - CG^2 = y^2 - x^2,$$

so that as $y^2 - x^2$ also equals $R^2 - a^2$

$$AG^2 - CG^2 = R^2 - a^2$$

from which

$$AG + CG : R + a = R - a : AG - CG.$$

In this last equation, all lines are known, except $AG - CG$. The length of this line can be found by construction, as it is the fourth proportional to $AG + CG$, $R + a$, and $R - a$. This will locate the point G.

Having found this point, G, we now proceed as follows: Erect a perpendicular to AC in the point G. This line intersects the line QP in a point D. From this point D draw the tangent to the given circle A. The point of contact B will be also a point of the circle to be described. The problem

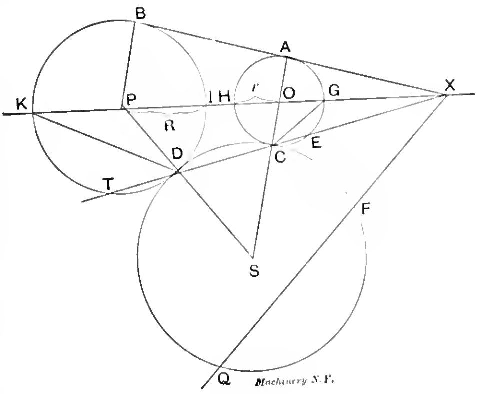


Fig. 2.

is now reduced to the problem of describing a circle which shall go through three given points, B, P and Q. As the solution to this problem is even older than 2,500 years, I will assume that it has become known by this time.

We now come to problem No. 2. (See Fig. 2.) O and P are the centers of the given circles; and Q is the given point. In order to come to a solution of this problem, we will analyze it by assuming again that the circle to be described has been found, and that its center is S. We draw the common center line, OP, and also the common tangent, BA, of the two given circles. These two lines intersect in the point X.

The points where the circle to be described touch the other circles, are called C and D. It is a well-known proposition that the line CD goes through the point X. Drawing the lines CG and KD, we find that triangles XCG and XKD are similar, because they have one angle in common, and the angles XCG and XKD are equal as they are measured by equal arcs:

$$\therefore XC : XG = XK : XD \text{ or}$$
$$XC \times XD = XG \times XK.$$

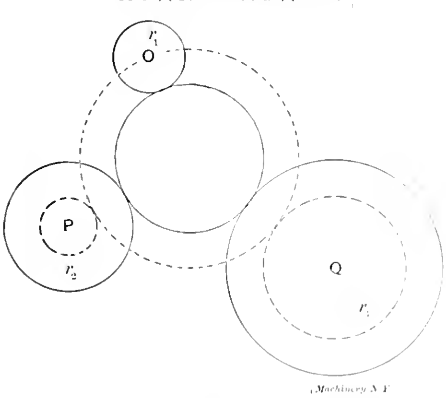


Fig. 3

We know further that $XC \times XD = XQ \times XF$, as XCD and XFQ are secants of the same circle, so that $XG \times XK = XQ \times XF$. In this last equation XF is the only unknown quantity, and it can be found as the fourth proportional to XQ, XK and XG. Having found this point F, the problem is reduced to the first problem, namely, to describe a circle, which is to touch a given circle, and which is to go through two given points.

Now consider the original problem. (See Fig. 3.) O, P and Q are the centers of the given circles, and their radii are $r_1 - r_2$ and r_3. We describe circles with P and Q as centers, and with radii equal to $r_2 - r_1$ and $r - r_1$ respectively. We then describe a circle, which touches the two new circles and which goes through the point O, working backward through problems No. 2 and No. 1. The center of this circle will be the center of the required circle.

Stripped from all demonstration and analysis, the solution is not complicated, and can be carried out by means of straight edge and compasses. No calculations are required. There are eight circles which fill the requirements: one, making external contact with all three circles; three, making external contact with two circles, and internal contact with one circle; three, making external contact with one circle, and internal contact with two circles; and one, making internal contact with all three circles.

The particular case of question, No. 14, is simpler, because two of the circles have the same diameter. This reduces the even circles to points, while the third circle becomes a negative one. Now a negative circle must look rather like a queer thing, but as a matter of fact, it simply means that the circle to be describ'd will make internal contact with that third circle and go through the centers of the other two. This particular case, therefore, skips one problem, and brings it down at once to problem No. 1.

Though the editor did not say so, I believe that he meant, that no simple solution has been proposed so far for the *calculation* of diameter and location of the circle which touches three given circles. If he meant this, then I agree with him. The fact that eight circles are possible, indicates that an equation expressing the location or diameter, would be of the eighth degree at least, and such an equation must be of a very special form if it shall be susceptible to direct solution.

* * *

Some months ago we gave a short editorial comment on unskilled labor, in which it was pointed out that unskilled labor, as such, was practically an unknown quantity. But, unfortunately, the skill which a laborer possesses in digging earth or in the handling of pig iron or shoveling coal is that which he has secured by experience and little of it is due to instruction. That it is possible to greatly increase the efficiency of laborers by instruction is interesting, but that in some classes of work it is possible to quadruple their efficiency is hardly believable. The skill of laborers in handling pig iron or shoveling coal consists only in lifting the greatest amount per day with the least effort, for his effective energy is strictly limited and must be conserved carefully, as otherwise he will be exhausted before the end of the day's work. In investigations conducted by Mr. Frederick W. Taylor along these lines it was found that most laborers waste considerable of their effort by false moves. For example, in unloading pig iron from a car, which work requires the lifting of pigs weighing, say, about 90 pounds, carrying them to the edge of the car and throwing them overboard, there was found to be a lack of continuous effort. The laborer would stoop down, pick up the pig stand for a moment and then start for the side of the car. It was suggested that the movements should be co-ordinated so that the impulse required to pick up the pig should be continued until it was dropped over the side of the car. The surprising result was found that where an ordinary laborer had been able to handle only about twelve tons per day, under the new system he handled about forty-eight tons per day. Again, in the matter of shoveling coal, the shape of the shovel and its size were found to be very important factors, and by studying the problem the amount of coal that could be handled by the average laborer with no greater tiring than before was greatly increased. From this experience it is quite evident that the training of laborers may be quite as important as the training for the so-called trades. The training of the laborer, of course, will be more that of muscle training than of brain training, but it is nevertheless quite as important in the cost of production where large quantities of materials must be handled by manual labor.

* * *

The value of the expression $x^2 + x + 41$ is a prime number for all whole values of x up to and inclusive of 39.

THE CONCRETE ERECTING SHOP OF THE INGERSOLL MILLING MACHINE COMPANY.

An interesting example of reinforced concrete shop construction is shown in the accompanying half-tones and line cuts, being the new erecting shop built in 1904-05 by the Ingersoll Milling Machine Co., Rockford, Ill. The building is, at present, 199 feet long and 60 feet wide; the main bay or erecting floor is 40 feet wide and the top of the crane tracks is 30 feet from the floor. It is built entirely of reinforced

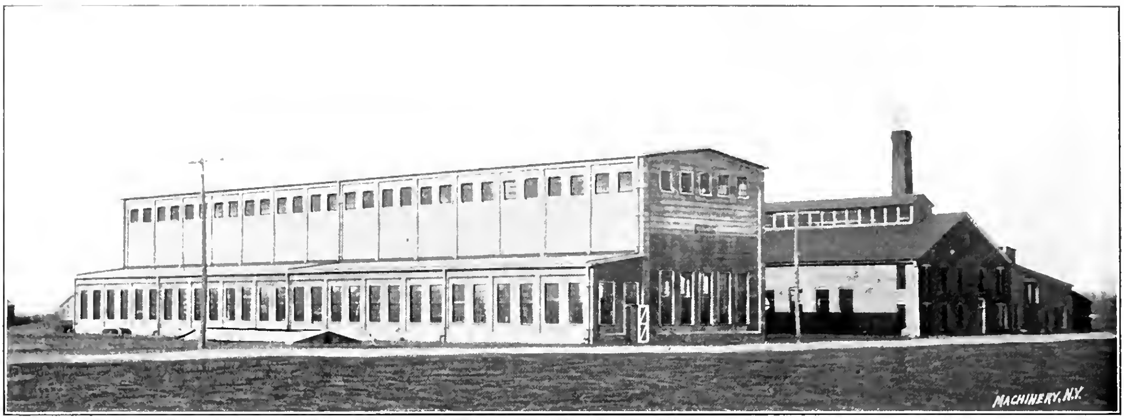


Fig. 1. The New Erecting Shop of the Ingersoll Milling Machine Company.

concrete with the exception of the roof. Even the crane runway girders are concrete, the reinforcement details of these appearing in Fig. 4. The use of concrete was decided on because of the plentiful deposit of sand and considerable gravel which underlaid the site. This fact, together with the growing use of concrete for general engineering structures naturally influenced the company toward the use of this

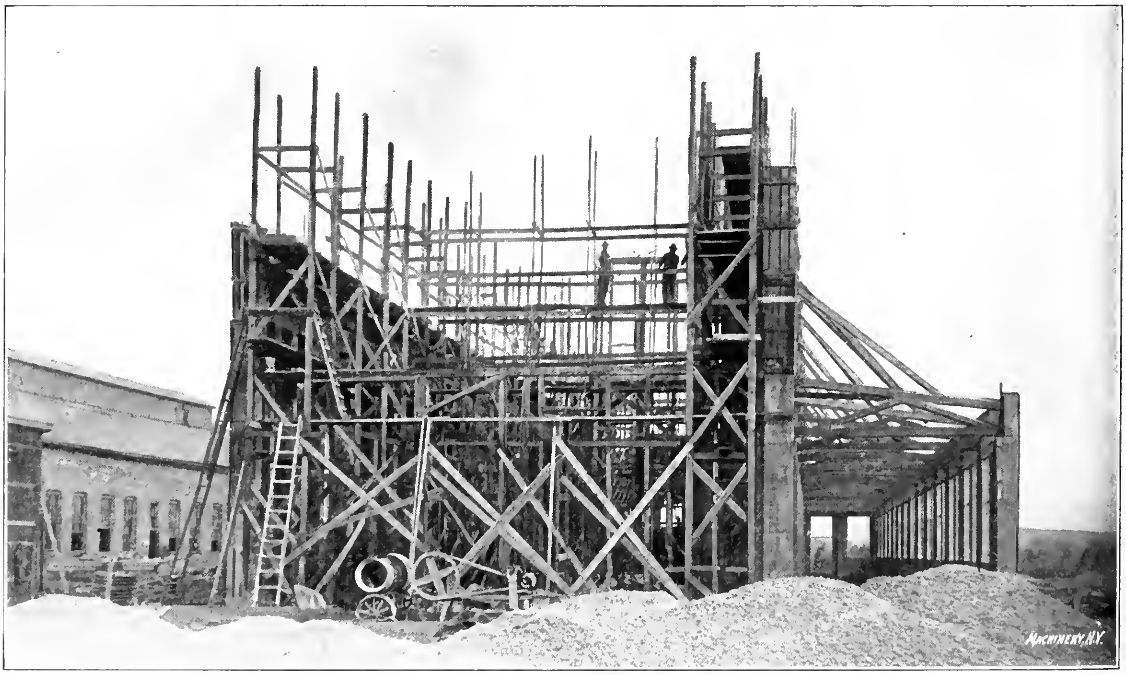


Fig. 2. Building the Concrete Walls, showing the Wooden Molds in place on the Upper Half of Wall.

material which, of course, meant a cheaper structure than one built of brick and safer and more durable than if built entirely of wood. Mr. W. W. Crehore, of New York, prepared the plans for the concrete work and his specifications as regards the reinforcement are as follows:

1. All rods shown, but not otherwise marked, are ¾ inch diameter.

2. All vertical corner rods in main piers and columns should have the ends squared to a true bearing where spliced. Splices for column rods shall be made of pipe sleeves—1-inch pipe for ¾-inch rods, and 1½-inch pipe for 1¼-inch rods. Each sleeve shall be about 16 inches long, and when set shall cover 8 inches of each rod spliced. After being set the space between the inside of the sleeve and the rods shall be filled with neat cement grout. (See illustration in Fig. 4.) Joints should alternate.

3. Double rods, either vertical or horizontal shall be banded together at intervals of 3 or 4 feet, but shall not be spaced so close together that they cannot be completely covered with concrete.

4. No rod shall be placed nearer than 1½ inch to the outside edge of the concrete in any direction.

5. Besides rods here shown there shall be, in the curtain walls all around the building, horizontal ½-inch rods and vertical ¾-inch rods about 3 or 4 feet apart.

6. There shall be no grease, oil, paint nor any foreign substance on the rods when set, and they should be scraped clean of all loose scale or rust. The surface need not be bright, however.

7. The concrete should be mixed just wet enough so that

it cannot be piled up. It should be put in the forms in small quantities, and thoroughly *stirred* to expel the air at once before beginning to harden.

The tops of the T-rails are ½ inch above the floor, and are drilled and tapped at short intervals for clamps. The details of the floor and pits are shown in Fig. 6. The pits are pro-

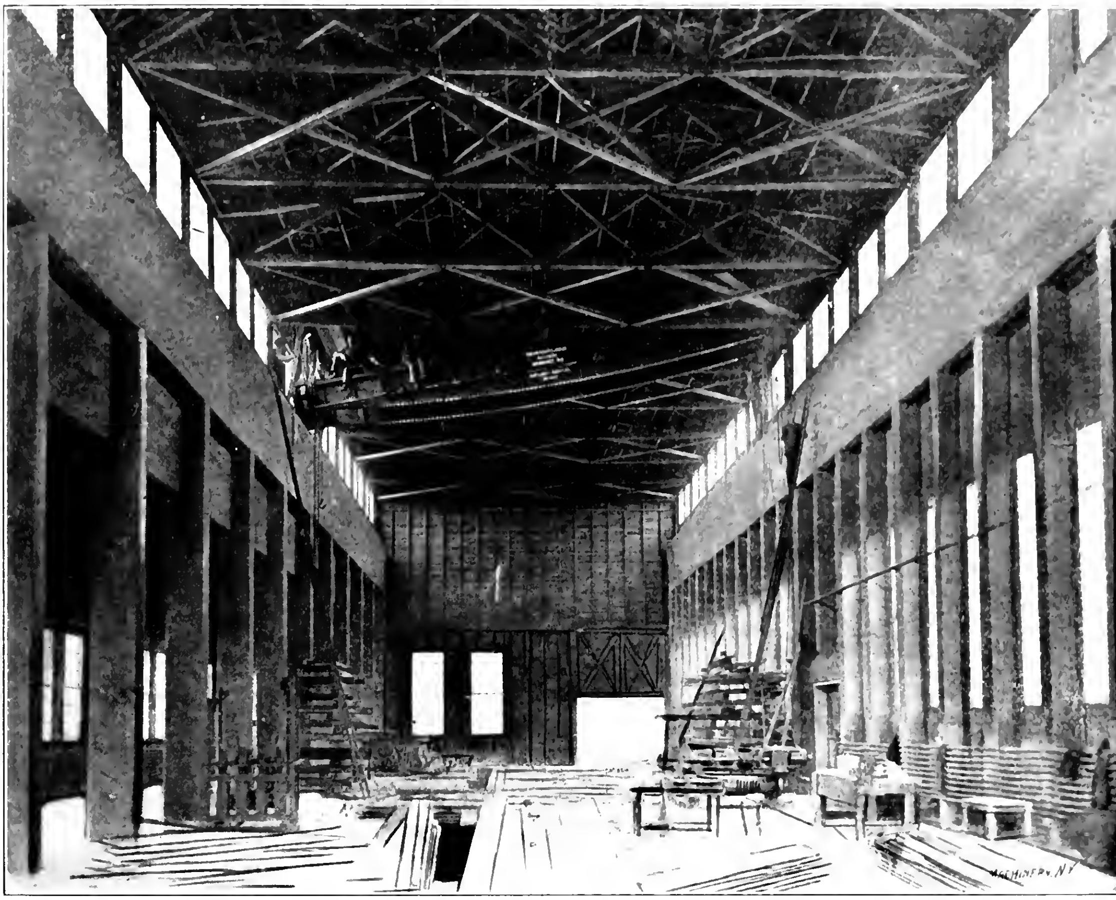


Fig. 3. Interior View taken while Crane was being Erected.

8. No concrete should be used after standing ready mixed for more than twenty minutes.

9. To prevent cracking or crumbling all concrete should be kept thoroughly wet until set solid.

10. To obtain a good bond and no voids around the iron rods, use no stone or gravel larger than ¾ inch in any dimension.

The proportions used in mixing the concrete were left largely to the discretion of the building superintendent, and were substantially as follows: 6 sacks of cement, 5 wheelbarrows of gravel or crushed stone, and 7 wheelbarrows of sand. It developed that not enough gravel was available from the company's gravel pit for the entire construction of the building, hence some crushed stone was used to complete the work; this was slightly larger than that specified, being of a size that would go through a 1 inch screen.

The interior of the erecting shop is shown in Fig. 3 at the time of the erection of the 20-ton traveling crane. The crane tracks are supported in pilasters of concrete, the details differing slightly from the drawing shown in Fig. 5 in that the inner face of the pilasters and crane track are in the same plane instead of the latter overhanging three inches, as shown in the cut.

The wing or side bay is about 15 feet wide in the clear. It is used for workbenches and the general fitting work connected with erecting. The floor in the side bay is of concrete about 4 inches deep; in the main bay it is 10 inches deep. Large floor plates are made in main floor by railroad rails which are bedded in it, spaced about 3 feet apart. Over the pits these rails rest upon 11-inch steel I-beams and the space between is filled in with reinforced concrete 6 inches deep.

vided, of course, for convenience in erecting so as to permit the men to get beneath the machines as they rest on the floor. A passage connects these pits, making communication

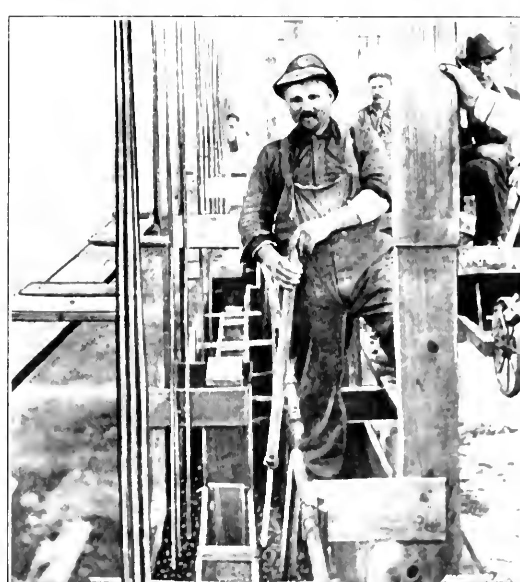


Fig. 4. Filling the Molds

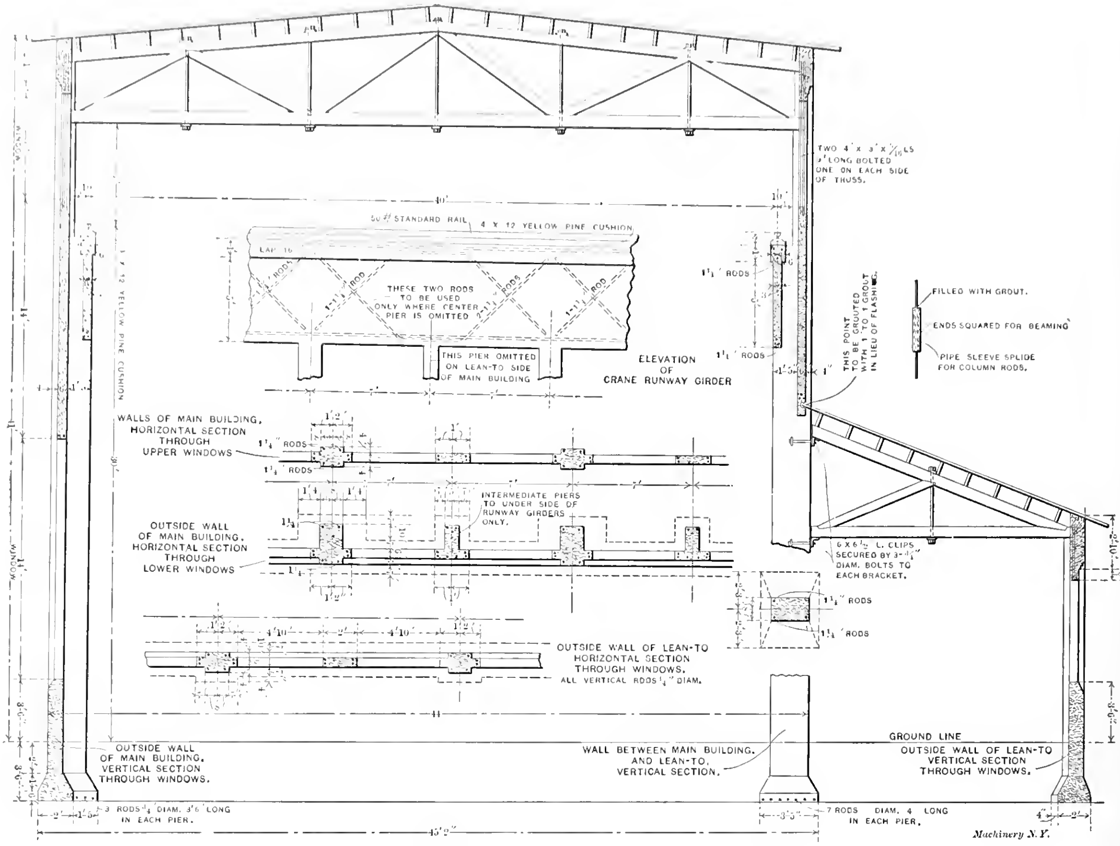


Fig. 5. Cross-section of Building, Details of Reinforcement, Etc.

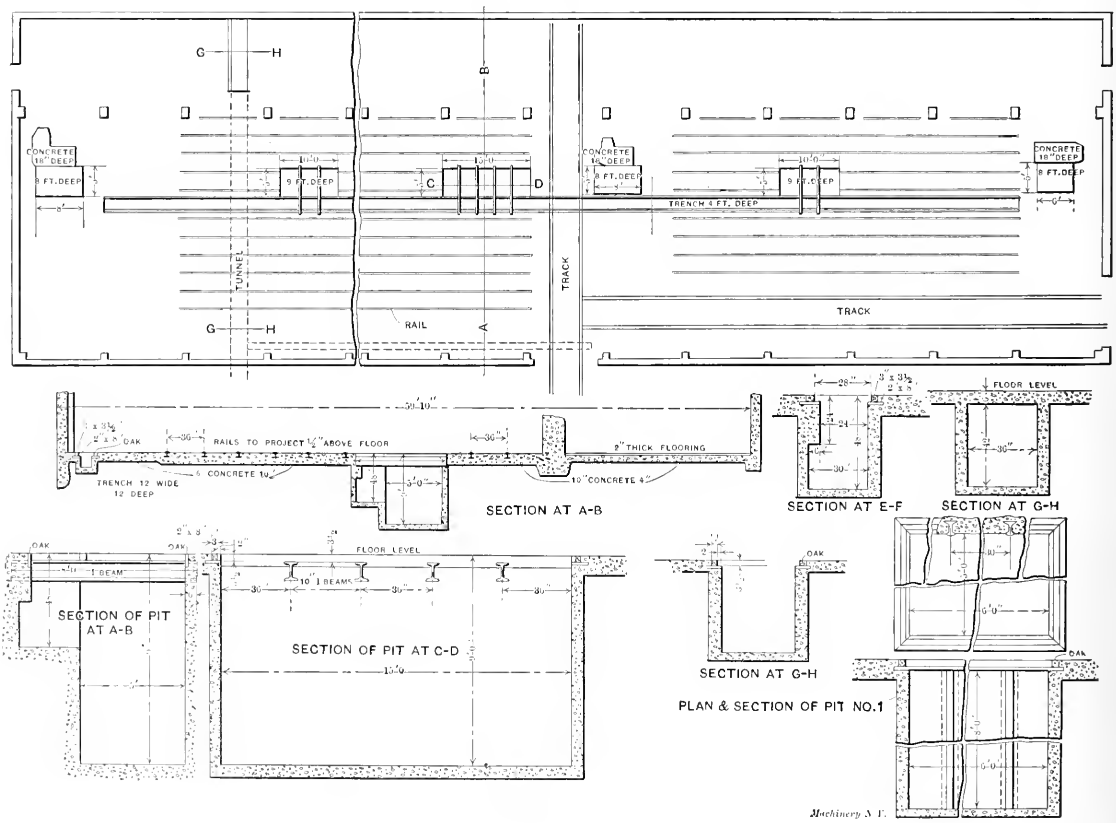


Fig. 6. Floor Plan and Details of Erecting Pits.

from one to another convenient and avoiding the necessity of climbing up upon the floor. A narrow-gage track made of $1\frac{1}{4}$-inch round iron is laid in the side bay to serve the workbenches. A transverse track leads into the machine shop through a covered passage connecting the two shops. This passage, in fact, is a connecting building and contains the tool room and wash room. The workbenches, by the way, are not set next to the outer walls as is the usual practice, but the space represented by the tracks separates them from the outer wall. Steam pipe coils are used for heating and these are located on the side walls below the windows. It is interesting to note that part of the concrete work of erection was done in the winter of 1904-5 when the thermometer was 15 degrees above zero, but by warming the sand, water and other material no trouble was experienced from freezing.

It is something of an anomaly in modern shop building to see a wooden superstructure used on concrete walls, but such is the case in this erecting shop. The roof is supported by wooden trusses which are strongly braced sidewise by diagonal struts between. These struts support the roof against the longitudinal surging stresses set by the traveling crane when suddenly started and stopped. There is no monitor in the roof, but windows high up in the sides admit plenty of light.

It may be a matter of wonderment on the part of some readers why a company building machine tools would require such a lofty erecting shop. We might say in explanation that this shop is in a certain sense an expression of the faith of Mr. Ingersoll in the milling machine and its future. And already one of the first erected in the new shop was the monster milling machine built for the Schenectady works of the General Electric Works which was illustrated in the November, 1905, issue. This tool, which will handle a cube measuring 10 feet and which weighs complete about 300,000 pounds, certainly required about practically the same shop facilities and space for handling as does the modern vertical compound steam engine of the larger powers. The present length of the erecting shop is 199 feet, but it is the intention to ultimately extend it to the same length as the machine shop, which is 312 feet 6 inches. In conclusion, we might mention what Mr. Ingersoll says in regard to the milling machine versus the planer in his own shop, and that is that he proposes to eliminate the planer entirely in his own work; in short, to take his own medicine to the limit.

* * *

At the fall meeting of the A. S. M. E., Mr. H. K. Jones told of his experience with the lubrication of line shafting at the Russell & Erwin plant of the Corbin Screw Corporation. In these shops there are about 3,000 feet of self-oiled shafting averaging about 2 7-16 inches in diameter and running from 150 to 500 revolutions per minute. Each of these pumps is "suction" oiled, some of them being provided with ring oilers at the ends as well. For many years "West Virginia native" oil was used, with entire satisfaction. A short time ago native oil becoming scarce, a black lubricant, a by-product of kerosene manufacture, was tried. This increased the friction by nearly 25 per cent, so the lubricant was changed to "engine" oil. This gave practically the same results as the "West Virginia native." A year or so ago, for the first time in thirty years, all the oil was cleaned from each hanger box. Apparently this cleaning had no effect on the amount of power necessary to run the shafting, so, since that time, the supply has simply been replenished occasionally without draining the reservoir. In a neighboring factory the shafting is supported by hangers with provision for both suction and ring oiling. An examination was made of these hangers and in many of them the oil had thickened and the rings stuck, but the wicking was working satisfactorily. The speaker showed a suction oil box which had been in use for thirty years on a shaft running at 300 revolutions per minute, much of the time working twelve or fourteen hours per day. Apparently the bearing surfaces were "good for at least 1,000 years," to use the speaker's words. The speaker's experience with these bearings, and others which have come under his observation, has led him to believe that the suction or capillary oiler is much more reliable than the ring oiler in the long run.

VARIABLE SPEED MECHANISMS.—9.

In this, the concluding article of the series on variable speed mechanisms, it may be of interest to make brief reference to a class of variable speed devices which was not mentioned in the general review of the art in the first article, May, 1905, and that is hydraulic variators. These devices resolve themselves essentially into some form of pump and motor, generally of the rotary class because of the obvious difficulty of making reciprocating motors work satisfactorily with a non-

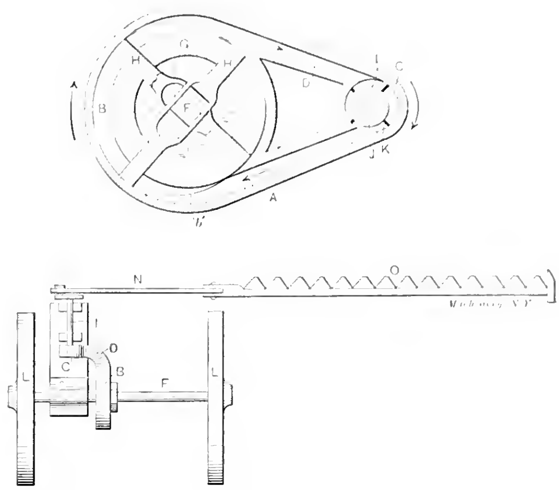


Fig. 76. A Mowing Machine Drive, Patented by L. Lapyre, August 15, 1882 No. 262,794.

expansive fluid and, of course, a non-expansive fluid such as water or oil is necessary for efficient power transmission.

The idea of power transmission by a hydraulic medium using a rotary pump and motor to give a higher velocity ratio of the motor is illustrated in the views shown in Fig. 76. This device, patented by L. Lapyre, August 15, 1882, No. 262,794, is not a variable speed apparatus but is simply a device for multiplying the speed of the driven shaft and at the same time changing the angle. The lower view shows its application to a mowing machine. It is obvious that if the capacity of the pump *B*, in the sectional view, could be decreased and that of the motor *C* increased, or *vice versa*, at will, the relative velocity ratio of the two would be changed. This is the general principle on which the hydraulic variator should be constructed. But a large number of the devices patented for changing speed have worked on the by-pass principle illustrated, for example, in Fig. 77.

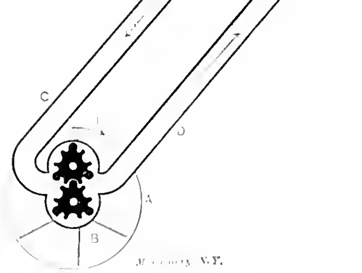


Fig. 77. The By-pass Idea, as Worked Out by James W. See, Patent No. 280,247, June 26, 1883.

This invention, patented by James W. See, June 26, 1883, No. 280,247, is called a device for transmitting motion. The patent specifications set forth the use of the shunt circuit *G* controlled by the regulating valve *H* through which the liquid may be diverted when it is desired to change the speed of the driven wheel *F*. The motor and pump, it will be observed, are each of the double mutilated gear type. The rotation of the pump *B* forces a definite amount of liquid through the circuit for

each revolution. If it is desired to lower the speed of F the regulating valve H must be opened so as to allow a portion of the liquid to by-pass and thus avoid passing through the motor. It is obvious, of course, that this method of controlling the speed is wasteful of power and is, in effect, much the same as applying a brake to a flywheel.

Fig. 78 is an illustration of the true speed variator of the hydraulic type, although of doubtful practicability. It was patented by A. P. Thayer, October 10, 1876, No. 183,081. In this device the pump is of the reciprocating type while the

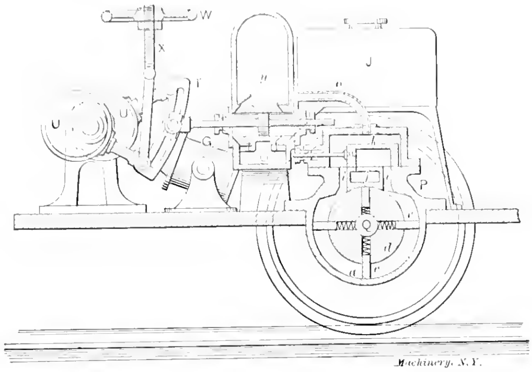


Fig. 78. Patent No. 183,081, granted to A. P. Thayer, October 10, 1876.

motor is of the rotary type, having radially moving vanes which move inward and outward when passing the abutment J. The stroke of the reciprocating pump is controlled by the position of the link T, this link being driven by two eccentrics UU. Raising the link by the hand wheel W shortens the stroke of the pump and slows down the motor. This part of the device, of course, is designed on the principle of the well-known Stephenson link motion. The function of the

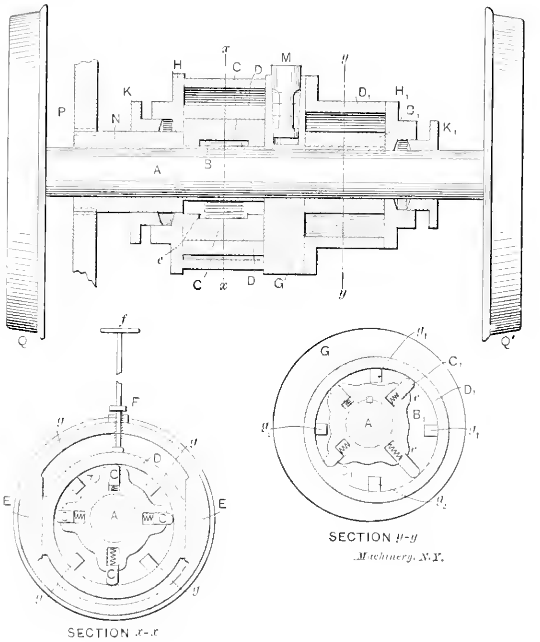


Fig. 79. Hydraulic Variable Speed Gear applied to Car Axle. Patent No. 466,660, granted to Louis Duncan, January 5, 1892.

slide valve K is that of reversal only. The cylinder shown at G is one of a pair of oscillating steam cylinders which drive the eccentric shaft.

Patent No. 466,660 was granted to Louis Duncan, January 5, 1892, for a hydraulic variable speed gear in which the capacity of the pump only, as shown in the cut, could be varied, but provision was made for varying the capacity of both the pump and the motor if such range is needful. The cut, Fig. 79, shows its application to the axle of a car. Section $x\,x$ shows a section through the pump and section $y\,y$ through the motor. The connection of the pump to the driving power is not shown. The valve M is for reversal of the motor, being in effect a two-way cock which transposes the closed circuit so as to effect reversal when required, or closes the connection between the pump and motor and short circuits the path of each. The springs shown at B and c are for holding the shell D against the controlling screw F. By screwing the case D up or down, the eccentricity of the shell with the shaft A is changed and consequently the capacity of the pump. The inlet and outlet ports are shown at g and g_1.

A patent was granted for an automobile vehicle December 19, 1899, No. 639,541 to F. S. and L. H. Dyer, and one feature of the invention is a variable capacity pump driven by an explosive motor. The pump was designed to circulate a variable column of water, oil, glycerine or other suitable liquid through a rotary motor, the variation in amount pumped increasing or decreasing the speed of the driving wheels. Fig. 80 shows the pump, the shaft C being connected to the crankshaft of a gasoline engine. To the end of the shaft C is keyed a spherical sector A, which is fitted in a spherical shell G. Opposing the

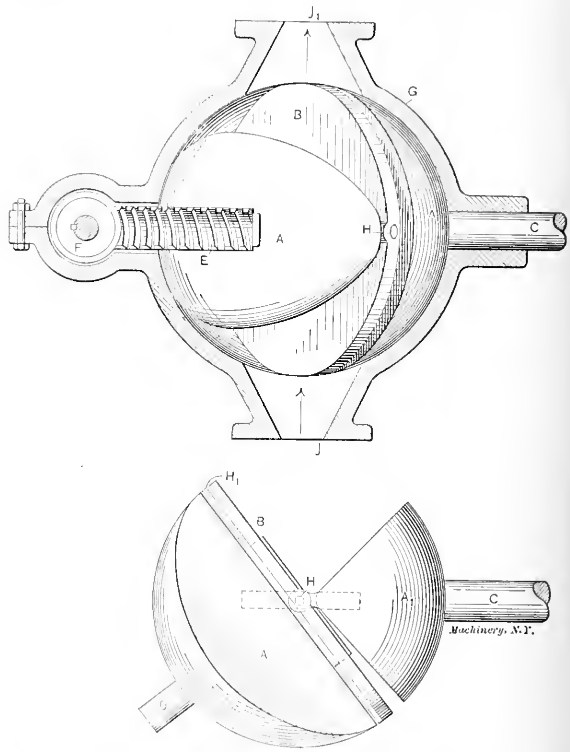


Fig. 80. Variable Capacity Pump. Patent No. 639,541, granted to F. L. and L. H. Dyer, December 19, 1899.

sector A_1 is another sector A and between the two is a movable wall or diaphram B made in the form of a circular disk and hinged to both A and A_1. The sector A has a short section of shaft D which acts as the pivot for its rotation. This pivot has a seat in the section of wormwheel E. F is a worm for changing the position for the mutilated wormwheel and of the pivot D, consequently when the shaft D and C are in line the two sectors and the disk B rotate idly without displacing liquid but upon changing the angular position of D, rotation of the sectors gives a wabbling motion to the disk B, causing expansion and contraction of the spaces between the sectors and the disk. The greater the angular displacement of D, the greater is the pumping action. The inlet and discharge ports $J\,J_1$ are so formed and located so that they serve both sides of the disk, two chambers drawing in and two discharging at the same time.

Fig. 81 shows a variable speed transmission patented by C., W. and S. Hibbard, June 7, 1904, No. 762,055. Only the side view of this invention is shown. There are three pumps, the cranks or eccentrics for which being indicated at $C\,C_1\,C_2$,

They all discharge into a common chamber from which the stream may be diverted in either of two directions in driving the rotary motor N, so as to effect reversal. The water after passing through the motor is returned to the tank and used over and over again, the same as in a closed circuit. The capacity of the pumps is changed by changing the position of the fulcrum E, one of which is provided for each walking beam. These fulcrums are on the ends of cranks mounted on a shaft which has a handle on the outside of the tank. By throwing the point E closer to the pump, the throw is shortened, and *vice versa.*

It is unfortunate that the hydraulic principle of speed variation has not received more attention than apparently has been bestowed upon it. Apparently no really practical and efficient

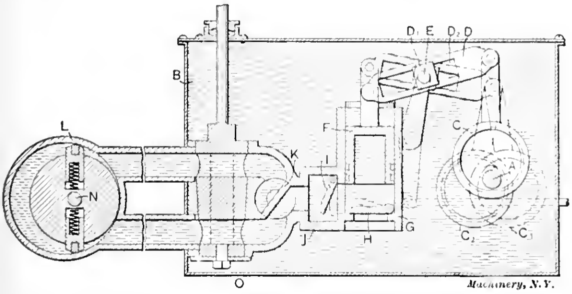


Fig. 81. Patent No. 762,055, granted to C. W. and S. Hibbard, June 7, 1904.

device has ever been brought into common use. We say that it is unfortunate because the principle of speed variation by changing the capacity of the pump or motor, or both, is one that permits of the finest relative adjustment of velocity ratio and it should be capable of effecting these changes with very simple construction. Leakage, of course, is the bane of all such devices, but with modern tools and methods of construction it would seem quite possible to build pumps of the rotary class that would be efficient, both in the matter of frictional resistance and freedom from leakage.

* * *

THE DESIGN OF BILLET AND BAR PASSES.

B. H. REDDY.

In practice, engineers and designers usually make use of methods for arriving at conclusions which are particularly adapted to their line of work. These methods may be original with themselves or they may be the methods of others modified to suit the requirements of their own particular practice. In the original design of work it is frequently very desirable that approximate results first be obtained in order that an idea may be formed of the best way in which to produce the desired results. In different lines, the work and plans of the engineer, however broad and thorough he may be, are very frequently subject to changes galore by the men who are familiar with the practical features and peculiarities and who are directly concerned in the repair and operation of the plant in process of development. During the discussions or conferences between the different men interested, short methods are especially desirable for quickly arriving at approximate results, and in the hope that it will prove of value to those who are interested in the design of billet and bar rolls, the writer will give a description of a method by means of which a series of such passes may be quickly proportioned.

Determining the Number of Passes.

In the designing of roll passes in general it is necessary that the sizes and shape of the finished product be known. The product being decided upon, the number and proportions of the passes, and the dimensions of the bloom or slab to be used must be fixed according to circumstances. The first feature to demand attention will quite likely be the number of passes the material will have to make through the rolls before being brought to the dimensions required. If the rolls are to be designed for a mill already existing this will depend upon the strength of the mill, the number of passes available in that mill, etc. On these limiting circumstances, and also on the available supply, will depend in a large measure the size of bloom or billet which can be used. When designing rolls for a new layout the conditions mentioned above do not apply, as the arrangement of the new mill will depend very largely on the product desired.

It is desirable first that the number of reductions or passes be at least approximated, depending, of course, on the shape of the section to be rolled, etc. By reduction is meant the difference between the area of cross section of the billet before passing through the rolls and after passing through, divided by the original area. For example, if a 4 x 4 billet becomes $2\frac{5}{8}$ x $4\frac{1}{4}$ after passing through the rolls the reduction would be found thus:

$$(4 \times 4) - (2\tfrac{5}{8} \times 4\tfrac{1}{4}) = 16 - 11.15625 = 4.84375.$$

$$\frac{4.84375}{16} = 0.3027 \text{ or } 30.27 \text{ per cent.}$$

Reductions vary from 60 per cent downwards, depending on strength of mill, engines, etc. A convenient formula for quickly obtaining the average reduction or number of passes is

$$P = 100\left(1 - \sqrt[n]{\frac{a}{A}}\right) \text{ where}$$

P = average per cent reduction
n = number of passes
a = finished area of billet
A = original area of billet.

For example, we will assume that a 4 x 4 billet is to be reduced to a $4\frac{1}{4} \times \frac{1}{4}$ strip in five passes. The formula will then appear as follows:

$$P = 100\left(1 - \sqrt[5]{\frac{1.0625}{16}}\right)$$

$$= 100\,(1 - \sqrt[5]{.06640625})$$
$$= 100\,(1 - .5813375)$$
$$= 100\,(.4186625) = 41.87 \text{ per cent, where}$$

A = original area of billet = 4 x 4 = 16
a = finished area of billet = $4\frac{1}{4}$ x $\frac{1}{4}$ = 1.0625

Of course it is understood that the reductions would not probably be made exactly to the figures given, for in practice they would have to be changed somewhat, but the result given is the average reduction and from this one is enabled to form a good idea of the work to be accomplished.

Drawing the Reduction Diagram.

Generally speaking, the first pass is a "shaping" pass or "leader," and usually does not have much draft, depending on the shape to be produced. Having determined, as previously described, the area of this first pass, and the total number of passes, or the average reduction, we may proceed to draw the diagram shown in Fig. 1, from which the series of passes may be proportioned. Draw two lines meeting at A and making an agle of 95.5 degrees with each other; bisect this angle with line AX. To locate line I, for a square bar, use the following formula:

$$\frac{A}{2.2} = z, \text{ in which}$$

A = area of pass
2.2 = constant for the angle of 95.5 degrees only
z = vertical dimension of pass on line AX (Fig. 1)

If the angle of 92 degrees is used, take 2.071 as the constant.

Assuming, for example, the area of the first pass to be 26.95 square inches and substituting this value in the formula, we have

$$\frac{26.95}{2.2} = z = 3.5 \text{ inches.}$$

Measuring off from point A on the line AX (Fig. 1), this distance locates a point through which draw a horizontal line (line I in this case). The line so obtained will be the horizontal dimension of the first pass.

Having found out by the preceding methods the horizontal line for the first pass, the corresponding line for the second may be found by the following formula, which is based on the principle that the areas of similar figures vary as the squares of their corresponding dimensions:

$z^2(1-a)=y$, in which

z = vertical dimension on line AX (Fig. 1)

y = vertical dimension of succeeding pass

a = required per cent reduction.

For the purpose of illustration, we will assume a reduction of 20.28 per cent, and taking the dimensions of pass No. 1, as found above, the formula would appear thus:

$$3.5^2(1-.2028)=3.125'' \text{ or } 3\tfrac{1}{8}''.$$

This distance laid off on line AX (Fig. 1) will locate a point through which line II (Fig. 1) will pass. In a similar way line III may be laid off from line II, and so on, until the required number of passes has been completed.

Directions for Laying Out Billet Grooves.

On the scale (Fig. 1) for 95.5 degrees, the horizontal lines numbered I to XV represent graphically the drafts of a corresponding number of grooves for Gothic and Diamond Roughing rolls laid out as previously described, and relate to an angle of 95.5 degrees only. Dotted lines for 92 degrees are drawn in, the use of which will be described later.

line XI.) The length of this line is the width of the groove on line AB. The tailoring curves at corners A and B are drawn with a radius of 1/10 the length of the side of the square.

Gothic Grooves: The depth AB and width CD, Fig. 6, are formed by referring to the scale (Fig. 1 angle of 95.5 degrees, line XI in this case). From the intersection E of the horizontal line CD with the perpendicular AB, lay off the distances EC and ED each equal to one half line XI on the horizontal line, and on the perpendicular line lay off the distance EA and EB each equal to the distance from A to line XI (Fig. 1). With a radius equal to AB draw curves AD, DB, BC and AC. By describing the tailoring curves at C and D with a radius equal to ¼ the diameter of the inscribed circle, the figure is completed.

Round Grooves: Draw horizontal line AA, Fig. 7, and perpendicular to it draw BC. From the point of intersection describe circle of required size. From centers $a\,a$ draw arcs $B\,D\,C$ and BGC; with same radius from points B and C draw intersecting arcs DE and FG. From these points of

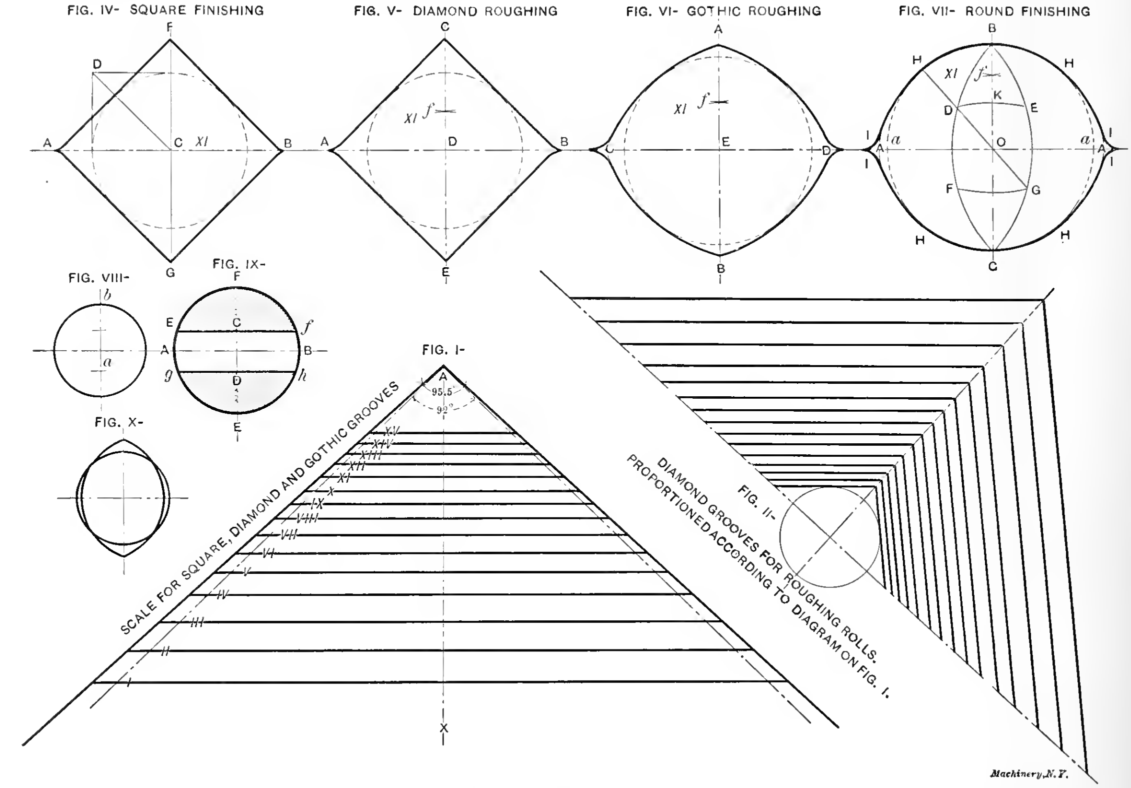


Diagram for Laying Out Billet Passes.

Diamond Grooves: Through line AB, Fig. 5, draw perpendicular line CDE. Refer to scale (Fig. 1, angle of 95.5 degrees) and take the vertical distance from horizontal line (XI in this case) to A, along line AX, and lay off the same from D to C and E respectively. Lay off the distance DA and DB, each equal to one-half line XI on scale (Fig. 1 angle of 95.5 degrees). Draw lines AC, CB, BE, and AE and the Diamond is formed. The tailoring curves at A and B complete the figure. These are described with a radius Df equal to ¼ the diameter of the inscribed circle.

Square Finishing Grooves: Through horizontal line AB, Fig. 4, draw perpendicular line FG. From point of intersection at C describe a circle with a diameter equal to side of square required. Draw two lines tangent to circle parallel to AB and FG respectively and intersecting at D and from C mark off CF and CG a distance equal to CD. From point A on scale (Fig. 1 angle of 92 degrees) mark off distance CD on perpendicular line AX, and draw through the point thus located a horizontal line intersecting the sides of the 92 degree angle. (In this case the line so located corresponds to

intersection, with radius GH describe the opening curves HI. The tailoring curves at II are drawn with a radius Bf or one half the distance BK.

Oval Grooves: Fig. 8 is the round for which the oval is intended. Draw the round and divide the diameter into three equal parts, and with a radius ab equal to two of these parts draw a circle, Fig. 9. The vertical diameter is divided into three equal parts. Through C and D draw lines parallel to the horizontal diameter AB. The segments $CEFf$ and $gDhE$ when put together form the oval required. See Fig. 10.

* * *

An interesting feature of the new turbine shop of the General Electric Co. is the fourteen Niles boring mills which are mostly used for facing Curtis turbine disks. All these machines are provided with water pans around the base so as to catch the drip from the tables, it being the practice to use water on the tools and run at high speed. All these boring mills have provision for facing tapers or rather of coning the sides of the disks. This is done by compound feed motion, the boring bar moving vertically while it feeds toward the center.

A METHOD OF PROCEDURE IN THE DESIGN OF HELICAL GEARS.

R. E FLANDERS.

In accordance with time-honored custom, this contribution to the art of designing helical or "spiral" gears opens with an apology. The subject is one which, from its very nature, can be approached from any one of a number of different ways, and it has been approached from so many of these possible different ways that perhaps the subject has become quite confused in the minds of many readers of technical

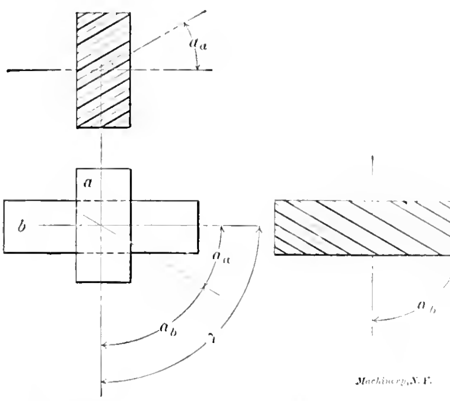


Fig. 1. Diagram showing Method of Lettering Tooth Angles.

papers. The writer does not offer the excuse of novelty in the methods presented in the following paragraphs, since some of the details which were independently worked out by him have been described by others. His reason for adding one more to the series of solutions of helical gear problems is that the method described appears to reduce the more serious of this class of problems to its most simple elements. The method of procedure will be described without proof or comment.

Two terms will be used which may require some explanation. In using the expression "tooth angle," the angle made by the teeth with the axis of the gear is meant, not the angle of the tooth with the face of the gear, an unfortunate use sanctioned by some writers. Fig. 1 shows α_a as the tooth angle of gear *a* and α_b as the tooth angle of gear *b*, used in the sense in which we will use them. The angle between the shafts, γ, is 90 degrees in all the examples which will be considered in this article. The first rule to be used in the design of helical gears relates to the tooth angles.

Rule 1. *The sum of the tooth angles of a pair of mating helical gears is equal to the shaft angle.*

That is to say, in Fig. 1, angle α_a added to angle α_b equals angle γ, as is self-evident from the cut.

The second term which requires explanation is the "equivalent diameter." The quotient obtained by dividing the number of teeth in a helical gear by the diametral pitch of the cutter used gives us a very useful factor for figuring out the dimensions of helical gears, so the writer has ventured to give it this name "equivalent diameter," an abbreviation of the words "diameter of equivalent spur gear," which more accurately describe it. This quantity cannot be measured on the finished gear with a rule, being only an imaginary unit of measurement. The next rule deals with this term.

Rule 2. *The equivalent diameter of a helical gear is found by dividing the number of teeth in the gear by the diametral pitch of the cutter with which it is cut.*

For instance, in a 20-tooth gear, cut with an 8 diametral pitch cutter, the equivalent diameter will be 2½ inches. The actual diameter of the gear will vary widely from this, depending on the tooth angle.

The process of locating a railway line over a mountain range is divided into two parts: the preliminary survey or period of exploration, and the final determination of the grade line. The problem of designing a pair of helical gears resembles this engineering problem in having many possible solutions, from which it is the business of the designer to select the most feasible. For the exploration or preliminary survey the diagram shown in Fig. 2 will be found a great convenience. The materials required are a ruler with a good straight edge, and a piece of accurately ruled, or, preferably, engraved cross-section paper. If a point, *O*, be so located on the paper that *B O*, the distance to one margin line, be equal to the equivalent diameter of gear *a*, while *B′ O*, the distance to the other margin line, be equal to the equivalent diameter of gear *b*, then, (when the rule is laid diagonally across the paper in any position that cuts the margin lines and passes through point *O*) *D O* will be the pitch diameter of gear *a*, *D′ O* the pitch diameter of gear *b*, angle *B O D* the tooth angle of gear *a* and angle *B′ O D′* the tooth angle of gear *b*. This simple diagram presents instantly to the eye all possible combinations for any given problem. It is, of course, understood that in the shape shown it can only be used for shafts making an angle of 90 degrees with each other.

The diagram as illustrated shows that a pair of helical gears having 12 and 21 teeth each, cut with a 5-pitch cutter, and having shafts at 90 degrees from each other and 5 inches apart, may have tooth angles of 36° 52′ and 53° 8′ respectively, and pitch diameters of 3 inches and 7 inches.

A correspondent has asked us to figure out the essential data for three sets of helical gears with shafts at right angles, as follows:

1st. Velocity ratio 2 to 1, center distance between shafts 2¼ inches.

2d. Velocity ratio 2 to 1, center distance between shafts 3⅜ inches.

3d. Velocity ratio 2 to 1, center distance between shafts 4 inches.

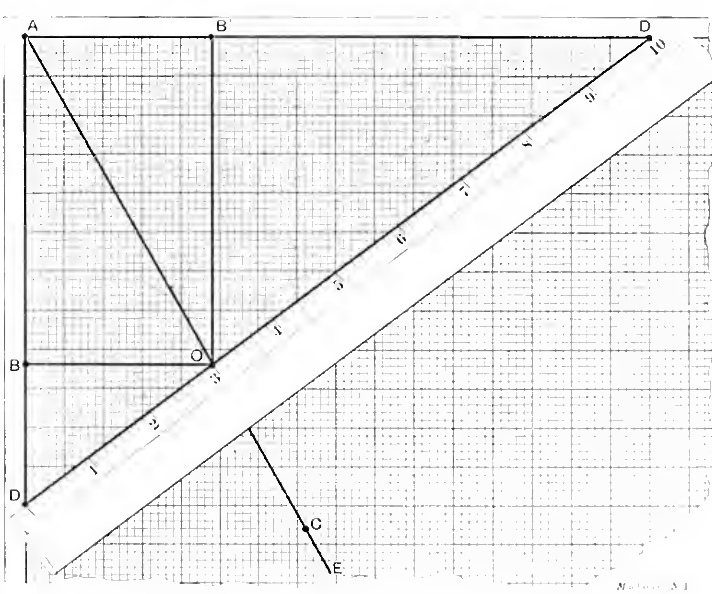


Fig. 2. Preliminary Solution with Rule and Cross-section Paper

We will take the first of these to illustrate the method of procedure about to be described.

We have a center distance of 2¼ inches and a speed ratio between driver and driven shafts of 2 to 1. The first thing to determine is the pitch of the cutter we wish to use. The designer selects this according to his best judgment, taking into consideration the cutters on hand and the work the gearing will have to do. Suppose he decides that 12-pitch will be about right. In Fig. 2 it will be remembered that *D O* was

the pitch diameter of gear a, while $D'O$ was the pitch diameter of gear b. That being the case DOD' is equal to twice the distance between the shafts. In the problem under consideration this will be equal to $2 \times 2\frac{1}{4}$, or $4\frac{1}{2}$ inches. Fig. 3 is a skeleton outline showing the operation of making the preliminary survey with rule and cross-section paper. AG and AG' represent the margin lines of the sheet, while DD' represents the graduated straight edge. By the conditions of the problem the distance between points D and D', where the ruler crosses the margin lines, must be equal to $4\frac{1}{2}$ inches. There has next to be determined at what angle of inclination the ruler shall be placed in locating this line. To do this, we will first find our "ratio line." Select any point C such that CF' is to CF as 2 is to 1, which is the required ratio of our gears. Draw through point C, so located, the line AE. Line AE is then the ratio line, that is, a line so drawn that the measurement taken from any point in it to the margin lines will be to each other in the same ratio as the required ratio between the driving and driven gear. Now, by shifting the ruler on the margin lines, always being careful that they cut off the required distance of $4\frac{1}{2}$ inches on the graduations, it is found that when the rule is laid as shown in position No. 1, cutting the ratio line at O', the distance from the point of intersection to corner A is at its maximum. For the minimum value, the tooth angle is the limiting feature. For a gear of this kind, 30 degrees is, perhaps, about as small as would be advisable, so when the ruler is inclined at an angle of about 30 degrees with margin lines AG' and occupies position No. 2 as shown, it will cut line AE at O'', and the distance cut off from the point of intersection to corner A will be at its minimum value. The ruler must then be located at some intermediate position between No. 1 and No. 2.

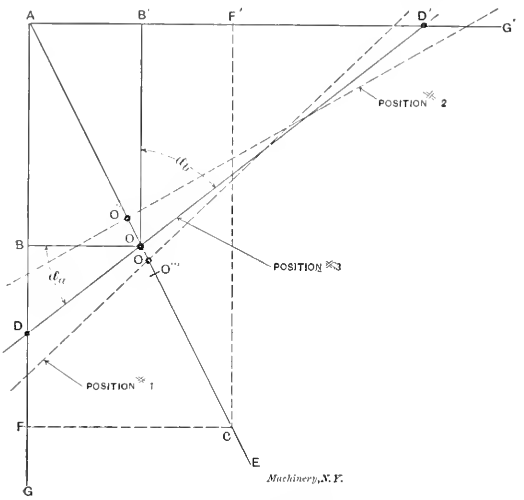


Fig. 3. Preliminary Graphical Solution for Problem No. 1.

Supposing, for example, 14 teeth in gear a and 28 teeth in gear b be tried. According to Rule 2, the equivalent diameter of gear a will then be $14 \div 12$, or 1.1666 inch; the equivalent diameter of b will be $28 \div 12$, or 2.3333 inches. Returning to the diagram to locate the point of intersection, it will be found that point O''' is so located that lines drawn from it to AG and AG' will be equal to 1.1666 inch and 2.3333 inches respectively, but this is beyond point O', which was found to be the outermost point possible to intersect with a $4\frac{1}{2}$-inch line, DD'. This shows that the conditions are impossible of fulfillment.

Trying next 12 teeth and 24 teeth, respectively, for the two gears, the equivalent diameters by Rule 2 will be 1 inch and 2 inches. Point O is now so located that OB equals 1 inch and OB' equals 2 inches. Now, seeing this falls as required between O' and O'', stick a pin in at this point to rest the straight edge against, and shift this straight edge about until it is located in such an angular position that the margin lines of AG and AG' cut off $4\frac{1}{2}$ inches, or twice the required distance between the shafts, on the graduations. This gives the preliminary solution to the problem. Measuring as carefully as possible, DO, the pitch diameter of gear a, is found to be about 1.265 inch diameter, and $D'O$, the pitch diameter of gear b, about 3.235 inches. Angle BOD, the tooth angle of gear a, measures about 37° 50′. Angles $B'OD'$, the tooth angle of gear b, would then be 52° 10′ according to Rule 1. To determine angle BOD more accurately than is feasible by a graphical process, use the following rule:

Rule 3. *The tooth angle of gear a in a pair of mating helical gears, a and b, whose axes are 90° apart, must be so selected that the equivalent diameter of gear b plus the product of the tangent of the tooth angle of gear a by the equivalent diameter of gear a, will be equal to the product of twice the center distance by the sine of the tooth angle of gear a.*

That is to say, in this case, $OB' + (OB \times$ the tangent of angle $BOD) = DD' \times$ the sine of angle BOD. Perform the operations indicated, using the dimensions which were derived from the diagram, to see whether the equality expressed in this equation holds true. Substituting the numerical values:

$$2 + (1 \times 0.77661) = 4.5 \times 0.61337,$$

$$2.77661 = 2.76016,$$

a result which is evidently inaccurate.

The solution of the problem now requires that other values for angle BOD, slightly greater or less than 37° 50′ be tried until one is found that will bring the desired equality. It will be found finally that if the value of 38° 20′ be used as the tooth angle of gear a, the angle is as nearly right as one could wish. Working out rule 3 for this value:

$$2 + (1 \times 0.79070) = 4.5 \times 0.62024,$$

$$2.79070 = 2.79108.$$

Giving a difference of only 0.00038 between the two sides of the equation. The final value of the tooth angle of gear a is thus settled as being equal to 38° 20′. Applying Rule 1 to find the tooth angle of gear b we have: $90° - 38°\ 20' = 51°\ 70'$. The next rule relates to finding the pitch diameter of the gears.

Rule 4. *The pitch diameter of a helical gear equals the equivalent diameter divided by the cosine of the tooth angle; or the equivalent diameter multiplied by the secant of the tooth angle.*

If a table of secants is at hand it will be somewhat easier to use the second method suggested by the rule, since multiplying is usually easier than dividing. Using in this case, however, the table of sines and performing the operation indicated by rule 4 we have for the pitch diameter of gear a:

$$1 \div 0.78442 = 1.2748, \text{ or } 1.275 \text{ inch, nearly;}$$

and for the pitch diameter of gear b:

$$2 \div 0.62024 = 3.2245, \text{ or } 3.225 \text{ inch, nearly.}$$

To check up the calculations thus far, the pitch diameter of the two gears thus found may be added together. The sum should equal twice the center distance, thus:

$$1.275 + 3.225 = 4.500,$$

which proves the calculations for the angle.

Rule 5. *The outside diameter of a helical gear equals the pitch diameter plus the quotient of 2 divided by the diametral pitch of the cutter used.*

Applying this rule to gear a:

$1.2748 + (2 \div 12) = 1.2748 + 0.1666 = 1.4414 = 1.441$ inch, nearly.

For gear b:

$3.2245 + (2 \div 12) = 3.2245 + 0.1666 = 3.3911 = 3.391$ inches, nearly.

In cutting spur gears of any given pitch different shapes of cutters are used, depending upon the number of teeth in the gear to be cut. For instance, according to the Brown & Sharpe system for involute gears eight different shapes are used, for a gear from 12 teeth to a rack. The fact that a certain cutter is suited for cutting a 12-tooth spur gear is no sign that it is suitable for cutting a 12-tooth helical gear, since the fact that the teeth are cut on an angle alters their shape considerably. To find out the number of teeth for which the cutter should be selected, use the following rule:

Rule 6. *The number of teeth for which the cutter should be selected to cut a helical gear is found by dividing the number of teeth in the gear by the cube of the cosine of the tooth angle.*

Applying this rule to gear *a:*

$$12 \div 0.784^3 = 12 \div 0.4818 = 25—,$$

and for gear *b:*

$$24 \div 0.620^3 = 24 \div 0.2383 = 100 +,$$

giving, according to the Brown & Sharpe catalogue, cutter No. 5 for gear *a* and cutter No. 2 for gear *b*.

In gearing up the head of the milling machine to cut these gears it is necessary to know the lead of the helix or "spiral" required to give the tooth the proper angle. To find this, use rule 7.

Rule 7. *The lead of the helix or "spiral" of a helical gear is equal to the product of the co-tangent of the tooth angle by the pitch diameter by* 3.14.

In solving problems by this rule, as for Rule 6, it will be sufficient to use trigonometrical functions to three significant places only, this being accurate enough for all practical purposes. Solving by Rule 7 to find the lead to set up the gearing for in cutting *a:*

$1.275 \times 1.264 \times 3.14 = 5.060+$ or 5 1-16 inches, nearly;

for gear *b*:

$3.225 \times 0.790 \times 3.14 = 8.001—$ or 8 inches, nearly.

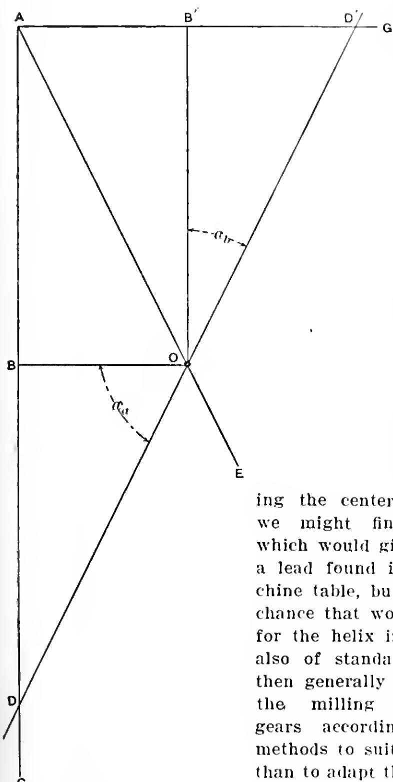


Fig. 4. Solution of Problem No. 2 for Equal Diameter.

The lead of the helix must be in general the adjustable quantity in any spiral gear calculation. If special cutters are to be made the lead of the helix may be determined arbitrarily from those given in the milling machine table; this will, however, probably necessitate a cutter of fractional pitch. On the other hand, by using stock cutters and varying the center distance slightly we might find a combination which would give us for one gear a lead found in the milling machine table, but it would only be chance that would make the lead for the helix in the mating gear also of standard length. It is then generally better to calculate the milling machine change gears according to the usual methods to suit odd leads, rather than to adapt the other conditions to suit an even lead. It will be found in practice that the lead of the helix may be varied somewhat from that calculated without seriously affecting the efficiency of the gears.

The remaining rules relating to the proportions of the teeth do not vary from those for spur gears and are here set down for the sake of completeness only.

Rule 8. *The thickness of the tooth of a standard gear at the pitch line is equal to* 1.5708 *divided by the diametral pitch of the cutter.*

For gears *a* and *b* of our problem this gives:

$$1.5708 \div 12 = 0.1309 \text{ inch.}$$

Rule 9. *The addendum of a standard gear is equal to* 1 *divided by the diametral pitch of the cutter.*

For gears *a* and *b* this will give:

$$1 \div 12 = 0.0833 \text{ inch.}$$

Rule 10. *The whole depth of the tooth of a standard gear is equal to* 2.1571 *divided by the diametral pitch of the cutter.*

This gives for gears *a* and *b*:

$$2.1571 \div 12 = .1797 \text{ inch.}$$

This completes all the calculations required to give the essential data for making the first pair of helical gears required by our correspondent. To illustrate the variety of conditions for which these problems may be solved the other cases will be worked out somewhat differently. In the case just considered no allowance was made for possible conditions which might have limited the dimensions of the gears and the problem was solved for what might be considered general good practice. Gear *a*, however, might have been too small to put on the shaft on which it was intended to go, while gear *b* might have been too large to enter the space available for it. If, as is quite likely, these gears are intended to drive the camshaft of a gas engine, the solution would probably be unsatisfactory. Case No. 2 will therefore be solved for a center distance of 3⅜ inches as required, but the two gears will be made of about equal diameter. Fig. 4 shows the preliminary graphical solution of this problem, the reference letters in all cases being the same as in Fig. 3. With a 10-pitch cutter, if this suited the judgment of the designer. 15 teeth in gear *a* and 30 teeth in gear *b* would require that the point of intersection on the ratio line *A E* be located at *O* where *B O* equals the equivalent diameter of gear *a*, which equals 1½ inch, while *B' O* equals the equivalent diameter of gear *b*, or 3 inches, both calculated in accordance with Rule 2. The required condition now is that *D O* be approximated to *D' O;* that is to say, that the pitch diameters of the two gears be about equal. After continued trial it will be found impossible to so locate *O*, using a cutter of standard diametral pitch, that *D O* and *D' O* shall be equal, and at the same time have *D D'* equal to twice the required center distance, which is $2 \times 3⅜$ inches or 6¾ inches. If this center distance could be varied slightly without harm *B D* could be taken as equal to *A B;* then it would be found that a line drawn from *D* so located through *O* to *D'*, though giving a somewhat shortened center distance, would make two gears of exactly the same pitch diameter.

Drawing line *D O D'*, however, as first described to suit the conditions of the problem, and measuring it for a preliminary solution the following results are obtained: The tooth angle of gear a = angle $B\ O\ D$ = 63° 45'; and the tooth angle of gear b = angle $B'\ O\ D'$ = 90° — 63° 45' = 26° 15', according to Rule 1. Performing the operations indicated in Rule 3 to correct these angles it is found that when the tooth angle of gear *a* is 63° 51', and that for gear *b* is 26° 6', the equation of Rule 3 becomes

$$3 + (15 \times 2.04125) = 6.75 \times .89803$$

$$6.06187 = 6.06170$$

which is near enough for all practical purposes. The other dimensions are easily obtained as before by using the remaining rules.

To still further illustrate the flexibility of the helical gear problem, the third case, for center distance of 4 inches, will be solved in a third way. It is shown in MacCord's Kinematics that to give the least amount of sliding friction between the teeth of a pair of mating helical gears, the angles should be so proportioned that, in our diagrams, line *D D'* will be approximately at right angles to ratio line *A E*. On the other hand, to give the least end thrust against the bearings, line *D D'* should make an angle of 45° with the margin lines *A G* and *A G'*, in the case of gears with axes at an angle of 90°, as are the ones being considered. The first example worked out in detail was solved in accordance with "good practice," when line *D D'* was located about one-half way between the two positions just described, thus giving in some measure the advantage of a comparative absence of sliding friction, combined with as small degree of end thrust as is practicable. To illustrate some of the peculiarities of the problem, Case 3 will now be solved to give the minimum amount of sliding friction, neglecting entirely the end thrust, which is considered to be taken up by ball thrust bearings or some equally efficient device. On trial it will be found that, with the same number of teeth in the gear and with the same pitch as in Case 2, giving in Fig. 5, *B O*, the equivalent diameter of gear *a*, a value of 1½ inch, and *B' O*, the equivalent diameter of gear *b* a value of 3 inches as in Fig. 4, line *D D'*, which is equal to twice the center distance or 8

inches, can then lie at an angle of about 90° with $A\ E$, thus meeting the condition required as to sliding friction. Thus this diagram, while relating to gears having the same pitch and number of teeth as Fig. 4 yet has an entirely different appearance, and gives different tooth angles and center distances, solving the problem as it does for the least sliding friction instead of for equal diameters of gears.

Measuring the diagram as accurately as may be the following results are obtained: Tooth angle of gear $a = B\ O\ D = 28°$; tooth angle of gear $b =$ angle $B'\ O\ D' = 90° - 28° = 62°$. This is the preliminary solution. After accurately working it out by the process before described we have as a final solution tooth angle of gear $a = 28°\ 28'$; tooth angle of gear $b = 61°\ 32'$. From this the remaining data can be calculated.

For designers who feel themselves skillful enough to solve such problems as these graphically without reference to calculations, the diagram may be used for the final solution. The variation between the results obtained graphically and those obtained in the more accurate mathematical solution is a measure of the skill of the draftsman as a graphical mathematician. The method is simple enough to be readily copied in a note book or carried in the head. If the graphical method is to be used entirely, it will be best not to trust to the cross section paper, which may not be accurately ruled; instead skeleton diagrams like those shown in Figs. 4, 5 and 6 may be drawn. For rough solutions, however, to be afterward mathematically corrected, as in the examples considered in this article, good cross section paper is accurate enough. It permits of solving a problem without drawing a line. Point O may be located by reading the graduations; a pin inserted here may be used as a stop for the rule, from which the diameter and center distance are read directly; dividing $A\ D$ read from the paper, by $D\ D'$, read from the rule, will give the sine of the tooth angle of the gear a.

For sensible people who prefer their rules to be embodied in formulas, the appended list has been prepared, using the following reference letters, which agree in general with the nomenclature of the Brown & Sharpe gear books.

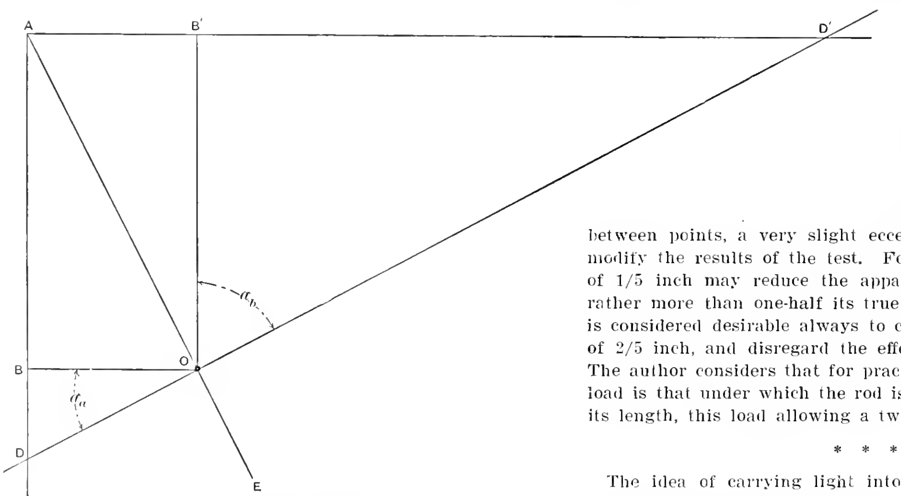


Fig. 5. Solution of Problem No. 3 for Minimum Sliding Friction.

N_a = No. of teeth in gear a.
N_b = No. of teeth in gear b.
R = Velocity ratio = $N_b \div N_a$.
P'' = Normal diametral pitch or pitch of cutter.
E = Equivalent diameter (explained above).
D = Pitch diameter.
C = Center distance.
B = Blank or outside diameter.
T = No. of teeth for which cutter is selected.
L = Lead of spiral.
γ = Angle of axes.
a = Angle of tooth with axis.
t = Thickness of tooth on pitch line.
S = Addendum.
$D'' + f$ = Whole depth of tooth.

Where subscript letters $_a$ and $_b$ are used reference is made to gears a and b, as for instance "N_a" and "N_b," where the letter N refers to the number of teeth in gear a and b, respectively of a pair of gears a and b.

$$\gamma = a_a + a_b. \qquad (1)$$

$$E = \frac{N}{P''}. \qquad (2)$$

$$E + (E \times \tan a_a) = 2\ C \times \sin a_a. \qquad (3)$$

$$D = \frac{E}{\cos a} = E \times \sec.\ a. \qquad (4)$$

$$B = D + \frac{2}{P''} \qquad (5)$$

$$T = \frac{N}{(\cos a)^3} \qquad (6)$$

$$L = \cot a \times D \times \pi. \qquad (7)$$

$$t = \frac{1.5708}{P''}. \qquad (8)$$

$$S = \frac{1}{P''}. \qquad (9)$$

$$D'' + f = \frac{2.1571}{P''}. \qquad (10)$$

* * *

BUCKLING STRAIN TESTS ON ROUND RODS WITH CLAMPED ENDS.

Theoretically the clamping of round rods at both ends should increase the resistance to buckling fourfold in comparison with the resistance offered when they are mounted between points. The tests performed by Prof. B. Kirsch, however, show that with slender rods the maximum increase is only threefold, and that in moderately slender rods ($\frac{l}{D} = 100$) the increase is not more than 13 per cent, says the *Mechanical World*. Another result of the tests is that in the case of test rods, 5 to 40 inches in length, with one free end, the other clamped, the point of maximum deflection is $1\frac{1}{4}$ to $2\frac{1}{8}$ inches nearer the clamped end than it should be theoretically. A further point of some importance is that, with test rods mounted between points, a very slight eccentricity suffices to greatly modify the results of the test. For instance, an eccentricity of 1/5 inch may reduce the apparent buckling strength by rather more than one-half its true value. For this reason it is considered desirable always to calculate on an eccentricity of 2/5 inch, and disregard the effect of clamping altogether. The author considers that for practical purposes the buckling load is that under which the rod is deflected by 1 per cent of its length, this load allowing a two-fold margin of safety.

* * *

The idea of carrying light into a room in pipes in very much the same manner as steam for heating, is one that is a decided novelty to most people, but it is substantially what the Moore Electrical Co. are doing in their system of electric lighting. Rooms lighted by the Moore system usually have a continuous tube of glass $1\frac{3}{4}$ inch diameter around the four sides near the ceiling and connected to a terminal box, in which are the bulbs containing the volatilizing substances and the electrical connections. This tube when producing light is filled with a glowing vapor of varying intensities and colors according to the service required. With this system it is possible to produce a white light having nearly the same characteristics as sunlight. It is claimed to be very economical in practice; 1.8 watts produce one candle power, or about three times as much for the same consumption of current as can be obtained from the incandescent lamps. Because of the absence of shadows it should be a lighting system worthy of attention for drafting rooms.

THE MANUFACTURE OF COLT'S AUTOMATIC ARMY PISTOL.

Six years ago the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., installed a plant for the manufacture of automatic pistols. These arms are unique in conception and design and are probably familiar to most readers of MACHINERY. A military model of this type, caliber 0.45, has recently been perfected and is illustrated in Figs. 1, 2 and 3 herewith; while the succeeding illustrations show some of the interesting machine operations upon certain parts of this pistol during its progress through the factory.

The arm can be discharged at the rate of five shots per second and is automatic except that the trigger must be pulled to fire each shot. The cartridges are automatically supplied from a detachable magazine inserted in the handle. After the pistol is charged with a filled magazine, one opening movement is made by hand, bringing the first cartridge into the chamber. On pulling the trigger the cartridge is fired, the empty shell ejected and the new cartridge loaded into the chamber. This automatic operation of the pistol is effected by the recoil of the moving parts and as a consequence the recoil is so absorbed in being utilized that it has not the usual disturbing effect.

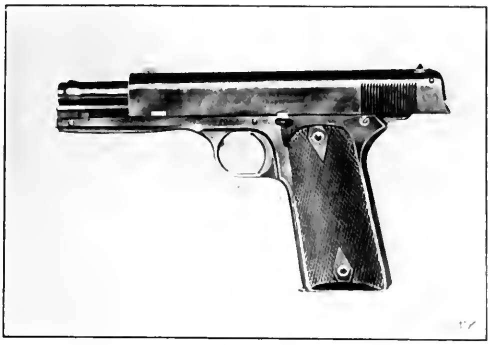


Fig. 1. Colt Automatic Army Pistol, Slide Drawn Back.

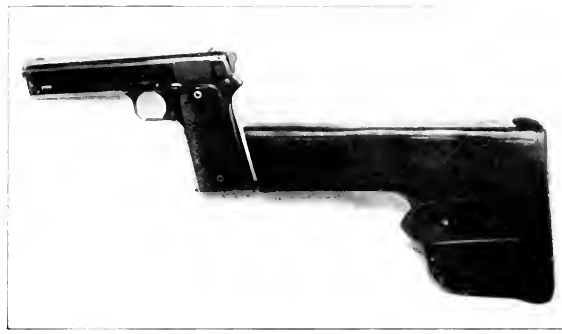


Fig. 2. Slide and Barrel Locked. Carrying Case Serving as a Stock.

The frame of the pistol, which constitutes the handle and supports the various parts of the mechanism, is a forging

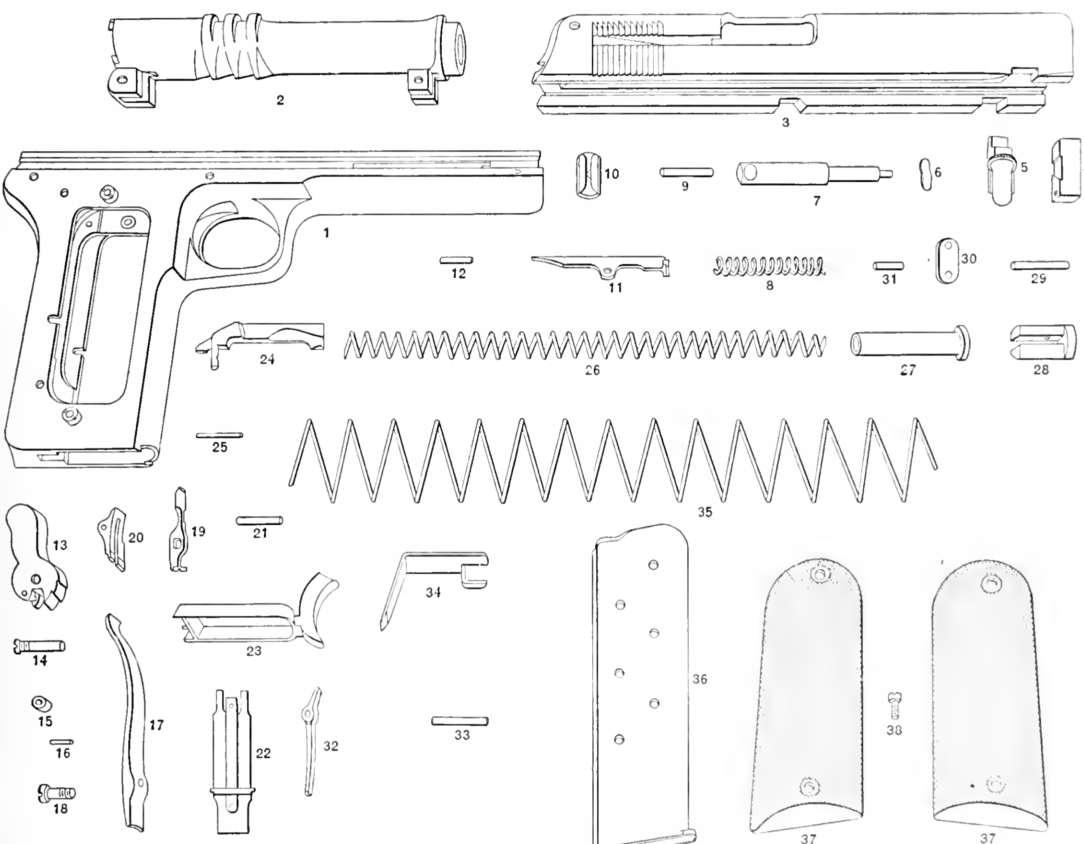


FIG. 3. COMPONENT PARTS OF AUTOMATIC COLT PISTOL, CALIBER 0.45.

1. Receiver.
2. Barrel.
3. Slide.
4. Slide Lock.
5. Slide Stop.
6. Slide Stop Spring.
7. Firing Pin.
8. Firing Pin Spring.
9. Firing Pin Lock Pin.
10. Rear Sight.
11. Shell Extractor.
12. Shell Extractor Pin.
13. Hammer.
14. Hammer Screw.
15. Hammer Roll.
16. Hammer Roll Pin.
17. Main Spring.
18. Main Spring Screw.
19. Safety.
20. Sear.
21. Sear and Safety Pin.
22. Sear, Safety and Trigger Spring.
23. Trigger.
24. Ejector.
25. Ejector Pin.
26. Retractor Spring.
27. Follower.
28. Plug (Take-down).
29. Plug and Link Pin (2).
30. Link (2).
31. Link Pin, Short (2).
32. Magazine Catch.
33. Magazine Catch Pin.
34. Magazine Follower.
35. Magazine Spring.
36. Magazine, Complete.
37. Stock, Sight and Left Hand, (per pair).
38. Stock Screws (4) Stock Screw Studs (4).

and is known as the receiver. The barrel is supported by the receiver and is covered by a slide which moves longitudinally in grooves milled in the sides of the receiver. These three parts are clearly illustrated in Fig. 3. When it is desired to fire the pistol, the slide is drawn to the rear by hand, thereby cocking the hammer. In this position the cartridge is pressed upward into the chamber where it comes into the path of the bolt. On releasing the slide the bolt and the cartridge are carried forward, the latter into the barrel, and the former at the same time forces the barrel into its forward position, where the several parts are locked together ready for the discharge. A slight pull on the trigger now releases the hammer and fires a shot and the recoil exerted against the bolt, and overcoming the inertia of the slide, causes the latter and the barrel to recoil together. The barrel, however, stops at a certain point and the slide continues on in its movement, thereby again cocking the hammer, compressing the retractor spring and ejecting the shell. The slide now returns automatically, the cartridge is driven into the barrel and the slide and barrel are interlocked as before.

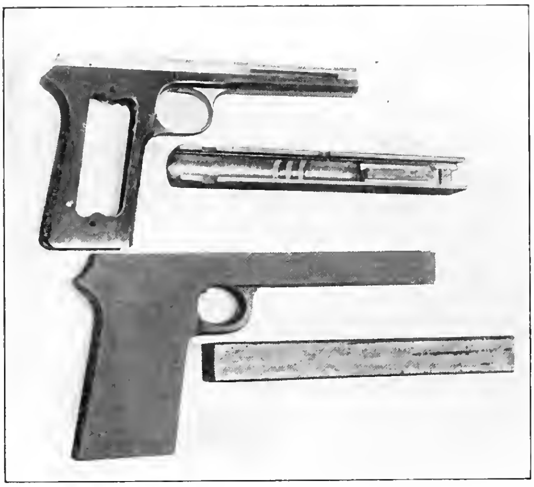


Fig. 4. Receiver and Slide Before and After Machining.

Fig. 1 shows the pistol with the slide and barrel moved backward ready to eject the empty shell. In Fig. 2 the slide and barrel are returned to their forward position. In this view the pistol is shown mounted on the end of its carrying case, which serves as a stock and makes an automatic shoulder piece capable of doing work nearly as effective as a rifle, in view of the fact that the recoil with this type of arm is very slight.

More than 500 operations are required in the manufacture of this pistol. The frame or receiver, the slide, the barrel, and other parts used in its construction are made from drop forgings of steel having a high tensile strength. To follow all these pieces through the many operations of milling, reaming, profiling, punching, etc., would make this article of too great length, and the views shown pertain to work upon the larger pieces, namely, the receiver, slide, and barrel.

From a bath or pickle for removing the light scale, the forgings go to the milling machines for the first operation of removing the rough exterior and then to the milling machines where the finishing operations are performed. After milling, the receiver goes to the profiling machines where the inside of the trigger guard, and that part in the handle cut away for the magazine, the main spring, safety, etc., are worked out to the proper depth. The metal in the handle that is cut away for the magazine which holds the cartridges is worked out by a special machine, which will be referred to later.

As the work progresses through the milling machines and profilers, the different operations are carefully gaged to insure complete interchangeability.

After milling, profiling and cutting away, to admit the magazine and limb work, the original forgings are naturally much reduced in weight, as indicated in Fig. 4, which shows a receiver and a slide both before and after the machine work has been done. The receiver for this sized pistol weighs two pounds in the forging and seven and one-half ounces when finished.

In another department the barrels are turned, bored and rifled, and in still another the manufacture of the smaller parts is carried on. After careful inspection and gaging the parts finally go to the polishing room and from there to the bluing room, then to the assembling room, and when assembled they go to the firing room where they are tested with the proof charges. Here any defects in the working of the arm, inaccuracies and imperfections are discovered. The arms are then cleaned, again inspected, oiled, boxed and placed in the stock room, ready for shipment.

The views shown in this connection tell their own story and require little description. All of the machines illustrated were designed and built at the Colt's Armory. The milling machines differ somewhat from the regular Lincoln type miller, although the spindle is adjustable vertically as in all manufacturing millers. The Colt miller is fitted with an overhanging arm such as is used with the knee-type milling machine, for steadying the cutter arbor. For heavy work this arm is supported at its outer end by a brace bolted to the frame, as in Figs. 5 and 6. This arm is made useful in other ways than by supporting the outer end of the cutter arbor, however, as in Fig. 8, where it carries an outer bearing in which a second spindle is mounted, making a double-spindle milling machine.

Another feature of these machines is a friction clutch for the belt cone, through which it drives the spindle. The clutch is made to throw out automatically by the action of a dog on the table, which can be set for any point in its travel, and is a feature that is useful when milling up to a shoulder, since it avoids milling a slight depression in the work such as always occurs when the feed is thrown out and the cutter is allowed to continue to rotate.

In Fig. 14 is a bridge milling fixture used in this instance for milling out the groove in the underside of the slide. This slot is of varying depth and its shape is controlled by the cam groove milled in the piece *B* attached to the under side of a swinging table pivoted to the support *C*, which latter is bolted to the main table of the milling machine. A pin projecting from a bracket secured to the frame of the machine acts as a guide for the cam. The pin is of a diameter to exactly fill the cam groove widthwise and as the table feeds it is raised or lowered according to the shape of the slot and the depth milled by the cutter is governed accordingly. The slide is held in fixture *A* during the milling operation.

In Fig. 16 a novel use is made of the milling machine. The pistol barrel is held in a chuck fitting in the tapered hole of the spindle and its outer end is supported by a tail spindle rotating in a bearing attached to a stationary upright arm. A formed cutter is held in the milling machine vise and as the table feeds under the rotating barrel this cutter forms the barrel to the required shape.

In Fig. 17 is a rotating milling fixture for taking a rotary milling cut at one end of the barrel, which is slightly eccentric with the main part of the barrel. The barrel is held in the spindle at *A*, at the outer end of which is the pinion and the handle *B*. This spindle has its bearings upon an auxiliary slide which can move longitudinally independently of the table feed. This slide is brought up against a stop by the hand wheel *D*; while the base to the slide, which is fastened to the carriage, is carried forward by the machine feed. The rack *C* is attached to this base and as it advances rotates the pinion and hence the barrel, which is held by the spindle *A*.

The rifling machine, Fig. 18, has four holders or chucks, one of which appears at *B*, for gripping the barrels during the rifling. The rifling tools *C* project from the carriage of the machine, which is oscillated by a crank and connecting rod driven by the large pulley at the left. The tools are given the rotary motion necessary to follow the spiral of the rifle groove by the sliding block *D* which travels back and forth in the diagonal slide as the carriage oscillates, and causes a rack meshing with pinions attached to the holders of the

rifling tools to move crosswise of the carriage and so give the necessary rotation to the tools.

The cutting points of the tools are mounted in grooves near the ends of the rods *C* and are gradually forced outward by conical plugs in the ends of these rods, which bear against the under sides of the cutters. With each forward movement of the carriage these plugs strike the stop pins *A*, which are gradually moved outward by the feed mechanism, causing the plugs to be driven inward a slight amount at each oscillation of the carriage.

There are six grooves in each barrel and in addition to the three movements mentioned above—the oscillation of the carriage, the rotation of the cutters, and the feed motion—the chucks carrying the barrels are rotated a sixth of a turn at each oscillation of the carriage. By this means the single pointed cutters operate upon the six rifle grooves in turn.

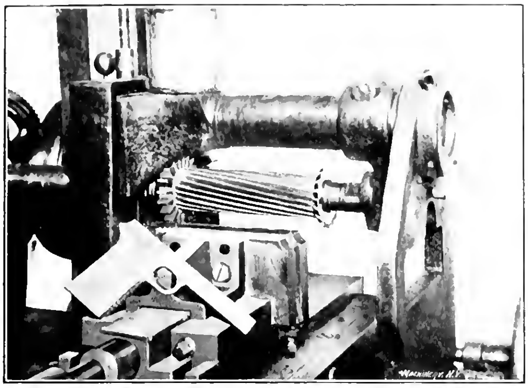


Fig. 5. Milling Top Edge of Receiver.

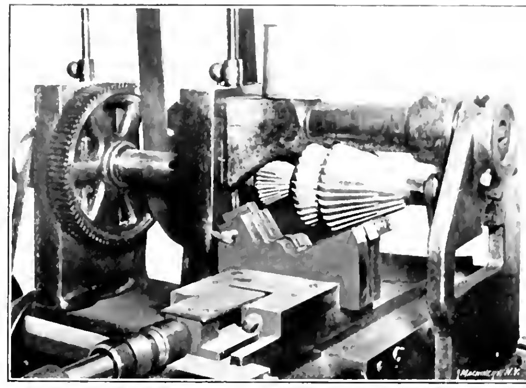


Fig. 6. Milling Bottom Edge of Receiver.

On an upper floor of Colt's armory is a large room given up to the inspection of the finished products of the factory and in Fig. 20 is a view of one corner of this room, where the automatic pistols are inspected. These are mounted on racks, as shown, containing 20 pistols each, for convenience in handling and to avoid injury in transferring from one part of

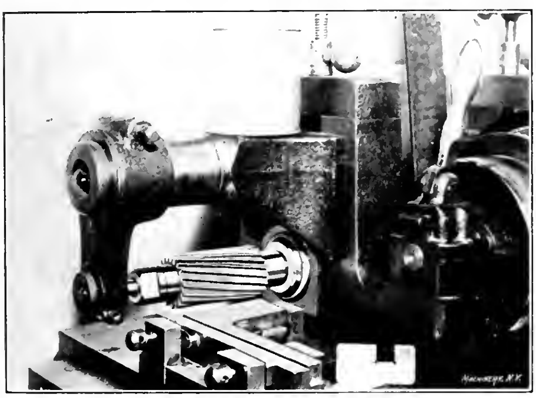


Fig. 7. Side Milling of Receiver.

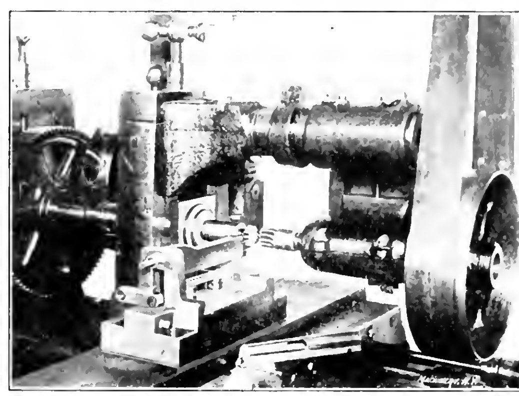


Fig. 8. Double Spindle Attachment taking Cuts on Slide.

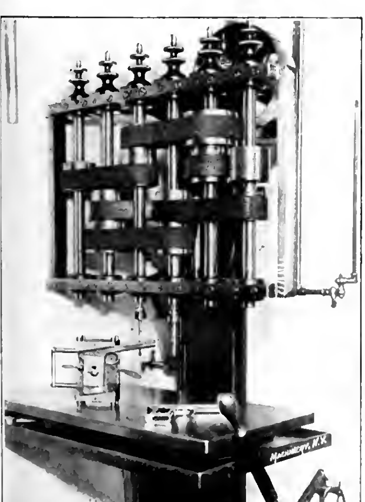


Fig. 9. Six-spindle Drill Press; Drilling Receiver for Magazine.

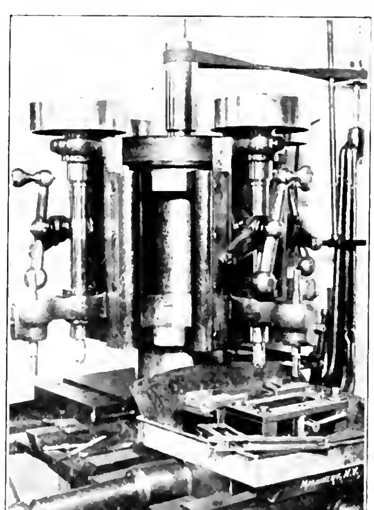


Fig. 10. Four-spindle Profiler at Work on Receiver. Spindles have Friction Drive.

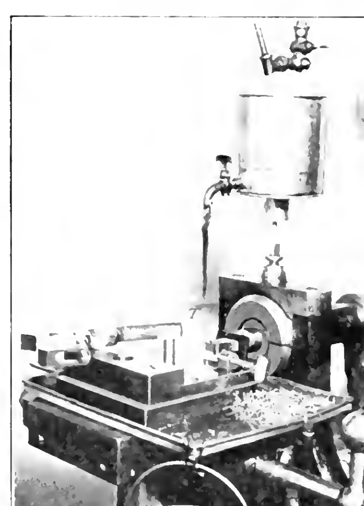


Fig. 11. Horizontal Slotter for Shaving Out Magazine Hole of Receiver.

the factory to another. Fig. 19 is from a photograph of a collection of gages all of which are used in the inspection of the parts of an automatic pistol. Similar sets are required for pistols of other calibers.

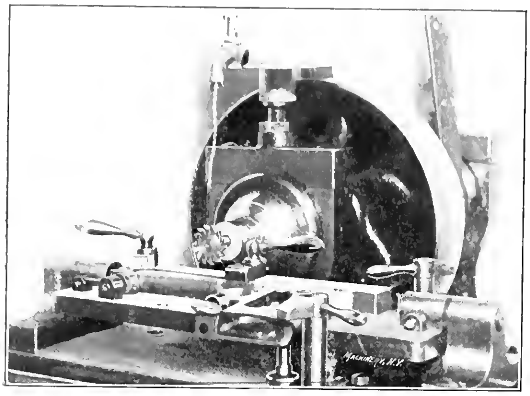


Fig. 12. Hand Milling Slot in Receiver in a Reversing Fixture.

The Colt's Patent Firearms Company are the only makers of automatic pistols in this country. The features of the arm are rapidity in firing, increase in the number of shots and

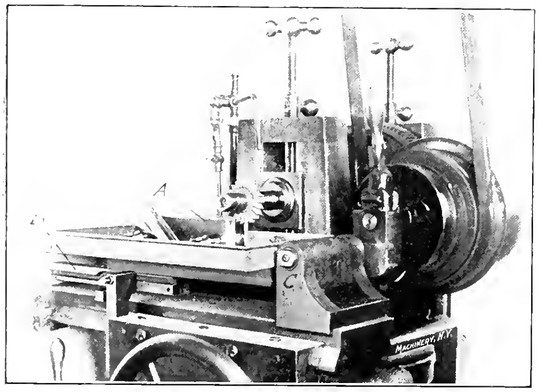


Fig. 14. Bridge Milling Slides.

less recoil. Under test it has been shown to have great penetration and to be extremely accurate. Tests have been made of the army size pistol, 0.45 caliber, at the Royal Small Arms Factory in England, for the British Army. Of the several

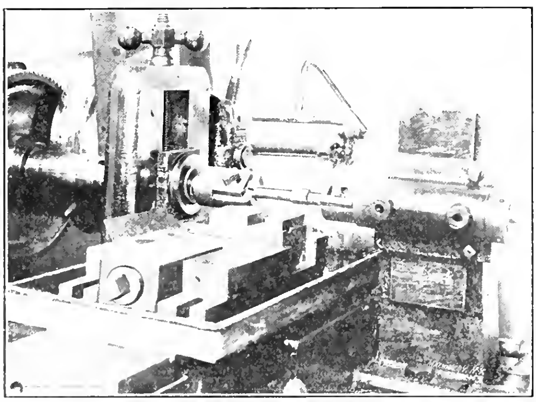


Fig. 16. Form Turning on the Milling Machine. The Barrel Rotates Tail Spindle; Form Cutter Attached to Table.

tests carried out, we will quote the following: Firing test for accuracy, distance 25 yards, 21 shots; 7 shots within 3-inch circle. Wet and dry sand test, 21 shots fired without cleaning. Penetration test, distance 30 yards, pentrated 11 one-inch pine boards placed at one inch apart. Velocity test, 7 shots gave 827.5 feet per second. A long series of accuracy tests were conducted subsequent to the accuracy test mentioned above, with the following results: Distance,

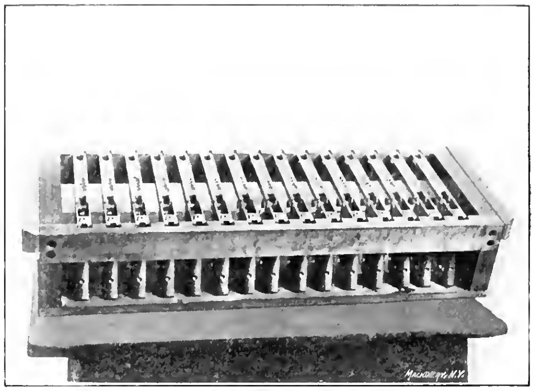


Fig. 13. Rack used for Holding Receivers during Progress of Work.

25 yards; 8 shots fired in a space of 3 inches, 8 shots fired rapidly in 4¾ inches, 14 shots fired rapidly in 5 inches, 7 shots in a space of 4 inches. At a distance of 30 yards: 8 shots in

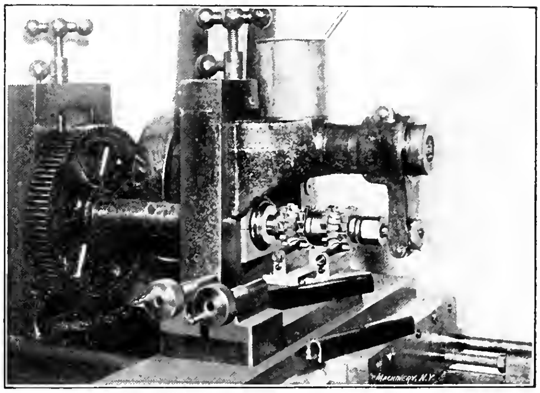


Fig. 15. Double Fixture used for Slides.

a 3¼-inch circle, 14 shots fired rapidly within 5 inches, 8 shots within 3¾ inches, 8 shots within 3⅛ inches.

The comments made upon the action of the mechanism and the practical operation of the arm were highly commendatory of the work of this American firm. It is stated that the

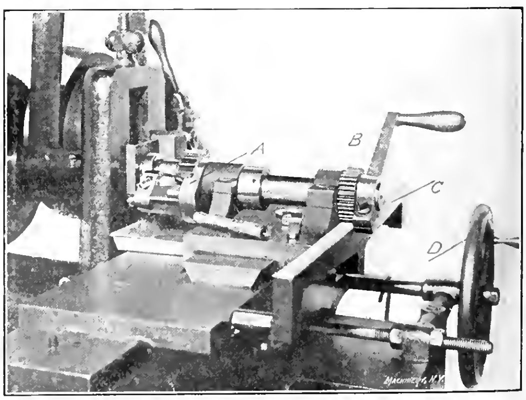


Fig. 17. Rotary Milling on the Barrel. A Special Fixture Rotates the Barrel while Cut is Taken.

ejection of the shell is upward and to the right and does not inconvenience the firer or the man on his right. No tests have as yet been made by the United States Army.

SHOULD A MECHANIC SIT WHILE WORKING?

A contributor has written us a communication on the subject "Should a Mechanic Sit While Working?" in which is discussed, with some warmth, the relative merits of making men stand or allowing them to sit when the nature of their work permits them to do so. It seems to us this question is one that is easily answered and any superintendent who is not competent to decide the matter in his own works is hardly the man to fill his position. A test that may be safely used for determining whether a man shall sit or stand at his work is to ascertain what his position would be if he were doing the same work on the piecework basis. If then he always stands, it is pretty safe to say that this position is the most advantageous for him, but, if on the other hand he finds that he can produce more work and do it easier by sitting, by all means let him sit. The old idea, and one still largely prevalent among many masters, is that workmen should be made about as uncomfortable as possible, seeming to think that in this way they are getting more for the wages paid. There was never a more mistaken idea, and the contrary policy, of course, is the one that wins out in the end. If a workman has a job at which he cannot move about to any great extent it certainly is very tiresome to always stand; he will become more wearied than if he were constantly on his feet and moving about during the same length of time.

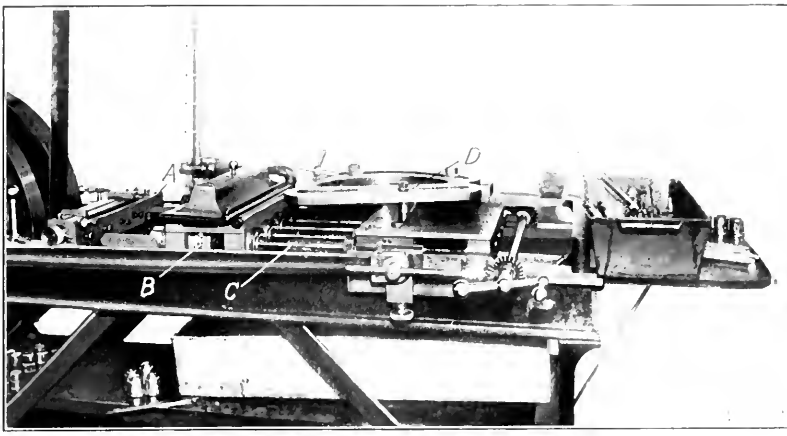


Fig. 18. Rifling Machine

To say that the proper handling of men is a great problem is only reiterating a well-known fact, but it is one we must never forget. There are many men, no doubt, who do not appreciate considerate treatment, and if they have a chance they will often reward kindness and fair treatment with contempt, and misuse of privileges. Such actions are hard to excuse and the tendency is to meet them with some reprisal on the shop as a whole. But we believe that rather than make a whole shopful of men suffer for the dirty work of a few it is better to discharge those few men and rely upon the good sense of the others to make the best use of the privileges allowed. If a man does not and will not appreciate the opportunity of directing his own work to the best mutual advantage, let him go elsewhere where such privileges are denied and work with those fellows who must be driven by the lash, as it were. So, in handling the question of whether a man shall stand or sit at his work, the conditions of that work should always govern; and educate the men so that these conditions rather than the mere presence of the foreman will govern them—let him be a director and not a "slave-driver."

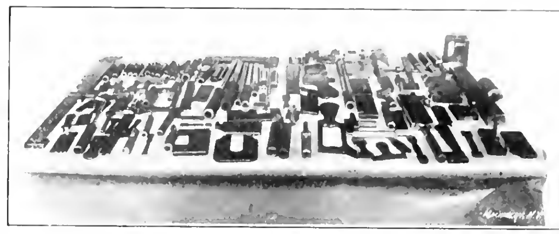


Fig. 19. Collection of Gages used in Inspection of Pistol Parts.

* * *

Don't take a heavy stock cut off with a planer and then a finishing cut without letting up on the work and allowing all of the strain to come out, and don't take a finishing cut on a broad surface of cast iron without first filing the scale on the front end all away as far down as the tool goes.

Fig. 20 Corner of Inspector's Department.

SOLID LATHE ARBORS.

H. D.

Convenient formulas and tables will be found below, giving well-proportioned dimensions for arbors to be used in a lathe.

A = total length.
B = length of actual arbor.
C = length of end, turned down for dog.
D = diameter of arbor.
E = diameter of end, turned down for dog.
F = distance of size from small end.

For arbors from ¼ to 2 inches diameter, use the following formulas:

$$A = 4D + 3.$$
$$B = 3D + 1\tfrac{5}{8}.$$
$$C = \frac{D}{2} + \frac{11}{16}.$$
$$E = \tfrac{7}{8} D.$$
$$F = \frac{D}{4} D + \frac{7}{16}.$$

For arbors from 2 1-16 to 4 inches diameter use the following formulas:

$$A = 3D + 5.$$
$$B = 2D + 3\tfrac{5}{8}.$$
$$C = \frac{D}{2} + \frac{11}{16}.$$
$$E = \tfrac{7}{8} D.$$
$$F = \frac{D}{2} + \frac{15}{16}.$$

In the table some dimensions that would figure out in 64ths have been given in 32ds when such approximation has been considered preferable.

Dimensions for flats for dog, and for counterbores and centers in ends of arbors ought to be as per formulas and table below.

G = diameter of drill.
H = depth of drilled hole.
I = diameter of center.
K = diameter of counterbore.
L = depth of counterbore.
M = width of flat for dog.

For arbors from ¼ to 2 inches diameter use the following formulas:

$$G = \frac{D}{16} + \frac{1}{32}. \qquad K = \frac{D}{4} + \frac{1}{8}.$$
$$H = \frac{D}{2}. \qquad L = \frac{1}{32}.$$
$$I = \frac{D}{8} + \frac{1}{8}. \qquad M = \frac{5}{16} D.$$

For arbors from 2 1-16 to 4 inches diameter use the following formulas:

$$G = \frac{D}{16} + \frac{1}{32}. \qquad K = \frac{D}{4} + \frac{3}{16}.$$
$$H = \frac{D}{8} + \frac{3}{4}. \qquad L = \frac{1}{16}.$$
$$I = \frac{D}{8} + \frac{1}{4}. \qquad M = \frac{5}{16} D$$

In the following table the diameter of the drill has been given according to Stub's steel wire gage. For arbors with very heavy duty the centers may be made somewhat larger than the dimensions in the table.

The dimensions for centers and flats have been carried out in table only for every one-eighth inch, as the differences in these dimensions are very slight.

It will be noticed that a dimension F has been given for the distance of size D from the small end of the actual arbor. This implies, as every one familiar with arbors knows, that the arbor is tapered. This is, of course, for allowing the arbor to find its way straight into the piece it is intended to support, and to allow for possible variations in the diameters of the holes. The taper should be made very slight, about 0.005 inch to the foot.

As far as the hardening of arbors is concerned, the practice of late has been to harden them all over. That this practice has been adopted at a rather recent date has probably been due

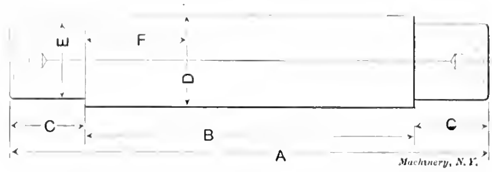


TABLE I. DIMENSIONS OF SOLID LATHE ARBORS.

D	A	B	C	E	F
1/4	4	2 3/8	13/16	7/32	5/8
5/16	4 1/4	2 9/16	27/32	9/32	43/64
3/8	4 1/2	2 3/4	7/8	11/32	23/32
7/16	4 3/4	2 15/16	29/32	3/8	49/64
1/2	5	3 1/8	15/16	7/16	13/16
9/16	5 1/4	3 5/16	31/32	1/2	55/64
5/8	5 1/2	3 1/2	1	9/16	29/32
11/16	5 3/4	3 11/16	1 1/32	19/32	61/64
3/4	6	3 7/8	1 1/16	21/32	1
13/16	6 1/4	4 1/16	1 3/32	23/32	1 3/64
7/8	6 1/2	4 1/4	1 1/8	25/32	1 3/32
15/16	6 3/4	4 7/16	1 5/32	13/16	1 9/64
1	7	4 5/8	1 3/16	7/8	1 3/16
1 1/16	7 1/4	4 13/16	1 7/32	15/16	1 15/64
1 1/8	7 1/2	5	1 1/4	1	1 9/32
1 3/16	7 3/4	5 3/16	1 9/32	1 1/32	1 21/64
1 1/4	8	5 3/8	1 5/16	1 3/32	1 3/8
1 5/16	8 1/4	5 9/16	1 11/32	1 5/32	1 27/64
1 3/8	8 1/2	5 3/4	1 3/8	1 7/32	1 15/32
1 7/16	8 3/4	5 15/16	1 13/32	1 1/4	1 33/64
1 1/2	9	6 1/8	1 7/16	1 5/16	1 9/16
1 9/16	9 1/4	6 5/16	1 15/32	1 3/8	1 39/64
1 5/8	9 1/2	6 1/2	1 1/2	1 7/16	1 21/32
1 11/16	9 3/4	6 11/16	1 17/32	1 15/32	1 45/64
1 3/4	10	6 7/8	1 9/16	1 17/32	1 3/4
1 13/16	10 1/4	7 1/16	1 19/32	1 19/32	1 51/64
1 7/8	10 1/2	7 1/4	1 5/8	1 21/32	1 27/32
1 15/16	10 3/4	7 7/16	1 21/32	1 11/16	1 57/64
2	11	7 5/8	1 11/16	1 3/4	1 15/16
2 1/16	11 3/16	7 3/4	1 23/32	1 13/16	1 31/32
2 1/8	11 3/8	7 7/8	1 3/4	1 7/8	2
2 3/16	11 9/16	8	1 25/32	1 29/32	2 1/32
2 1/4	11 3/4	8 1/8	1 13/16	1 31/32	2 1/16
2 5/16	11 15/16	8 1/4	1 27/32	2 1/32	2 3/32
2 3/8	12 1/8	8 3/8	1 7/8	2 3/32	2 1/8
2 7/16	12 5/16	8 1/2	1 29/32	2 1/8	2 5/32
2 1/2	12 1/2	8 5/8	1 15/16	2 3/16	2 3/16
2 9/16	12 11/16	8 3/4	1 31/32	2 1/4	2 7/32
2 5/8	12 7/8	8 7/8	2	2 5/16	2 1/4
2 11/16	13 1/16	9	2 1/32	2 11/32	2 9/32
2 3/4	13 1/4	9 1/8	2 1/16	2 13/32	2 5/16
2 13/16	13 7/16	9 1/4	2 3/32	2 15/32	2 11/32
2 7/8	13 5/8	9 3/8	2 1/8	2 17/32	2 3/8
2 15/16	13 13/16	9 1/2	2 5/32	2 9/16	2 13/32
3	14	9 5/8	2 3/16	2 5/8	2 7/16
3 1/16	14 3/16	9 3/4	2 7/32	2 11/16	2 15/32
3 1/8	14 3/8	9 7/8	2 1/4	2 3/4	2 1/2
3 3/16	14 9/16	10	2 9/32	2 25/32	2 17/32
3 1/4	14 3/4	10 1/8	2 5/16	2 27/32	2 9/16
3 5/16	14 15/16	10 1/4	2 11/32	2 29/32	2 19/32
3 3/8	15 1/8	10 3/8	2 3/8	2 31/32	2 5/8
3 7/16	15 5/16	10 1/2	2 13/32	3	2 21/32
3 1/2	15 1/2	10 5/8	2 7/16	3 1/16	2 11/16
3 9/16	15 11/16	10 3/4	2 15/32	3 1/8	2 23/32
3 5/8	15 7/8	10 7/8	2 1/2	3 3/16	2 3/4
3 11/16	16 1/16	11	2 17/32	3 7/32	2 25/32
3 3/4	16 1/4	11 1/8	2 9/16	3 9/32	2 13/16
3 13/16	16 7/16	11 1/4	2 19/32	3 11/32	2 27/32
3 7/8	16 5/8	11 3/8	2 5/8	3 13/32	2 7/8
3 15/16	16 13/16	11 1/2	2 21/32	3 7/16	2 29/32
4	17	11 5/8	2 11/16	3 1/2	2 15/16

to the increased demand for tools of strength and durability created by the high-speed steels and changed commercial conditions. But it can by no means be said that an arbor hardened all over will in the long run produce as *accurate* work as would an arbor hardened only at the ends, the actual arbor being left soft. The reason for this is easily explained and understood. When hardening the arbor all over severe internal stresses will occur, and after having been used for some

time, and hammered upon more or less when driving on and off pieces, these internal stresses will cause the arbor to spring and get out of true very easily. This will not occur with a soft arbor, hardened only at the ends, as no internal stresses of any amount have to be considered. To keep a soft arbor in good condition, and to keep it true, it is only necessary to use it with care. When really accurate work is desired, arbors hardened at the ends only should therefore always be used.

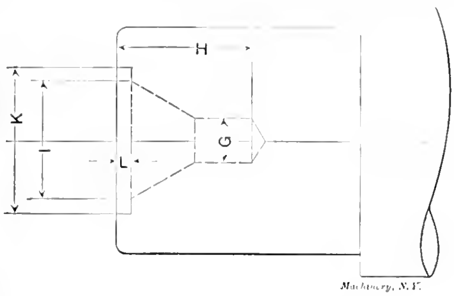


TABLE II. DIMENSIONS FOR CENTERS, FLATS, DRILLS, ETC. FOR SOLID LATHE ARBORS.

D	G	H	I	K	L	M
1/4	.045	1/8	5/32	3/16	1/32	5/64
3/8	.055	3/16	11/64	7/32	1/32	1/4
1/2	.063	1/4	3/16	1/4	1/32	5/32
5/8	.072	5/16	13/64	9/32	1/32	3/16
3/4	.079	3/8	7/32	5/16	1/32	15/64
7/8	.088	7/16	15/64	11/32	1/32	9/32
1	.095	1/2	1/4	3/8	1/32	5/16
1 1/8	.103	9/16	17/64	13/32	1/32	11/32
1 1/4	.110	5/8	9/32	7/16	1/32	25/64
1 3/8	.120	11/16	19/64	15/32	1/32	7/16
1 1/2	.127	3/4	5/16	1/2	1/32	15/32
1 5/8	.134	13/16	21/64	17/32	1/32	1/2
1 3/4	.143	7/8	11/32	9/16	1/32	35/64
1 7/8	.151	15/16	23/64	19/32	1/32	19/32
2	.157	1	3/8	5/8	1/32	5/8
2 1/8	.164	1 1/64	33/64	23/32	1/16	21/32
2 1/4	.172	1 1/32	17/32	3/4	1/16	45/64
2 3/8	.180	1 3/64	35/64	25/32	1/16	3/4
2 1/2	.188	1 1/16	9/16	13/16	1/16	25/32
2 5/8	.197	1 5/64	37/64	27/32	1/16	13/16
2 3/4	.204	1 3/32	19/32	7/8	1/16	55/64
2 7/8	.212	1 7/64	39/64	29/32	1/16	29/32
3	.219	1 1/8	5/8	15/16	1/16	15/16
3 1/8	.227	1 9/64	41/64	31/32	1/16	31/32
3 1/4	.234	1 5/32	21/32	1	1/16	1 1/64
3 3/8	.242	1 11/64	43/64	1 1/32	1/16	1 1/16
3 1/2	.250	1 3/16	11/16	1 1/16	1/16	1 3/32
3 5/8	.257	1 13/64	45/64	1 3/32	1/16	1 1/8
3 3/4	.266	1 7/32	23/32	1 1/8	1/16	1 11/64
3 7/8	.272	1 15/64	47/64	1 5/32	1/16	1 7/32
4	.281	1 1/4	3/4	1 3/16	1/16	1 1/4

[Where hardened arbors are desirable they should be "seasoned" before finish grinding, the same as plug gages, etc. This process relieves the internal stresses and reduces the probability of springing in use.—EDITOR.]

* * *

RULES FOR DRAFTSMEN.

In a paper, "The Hand Writing of Mechanics," *i. e.*, mechanical drawing—read by Mr. Eugene Ranson before the Ohio Society of Electrical Mechanics and Steam Engineers, the author spoke of the case with which a difficult mechanical idea can be conveyed to another by means of a few lines, and then referred to the want of standard practice in mechanical delineation. He gave a number of rules which in his opinion should be observed by mechanical draftsmen generally, one of which is as follows:

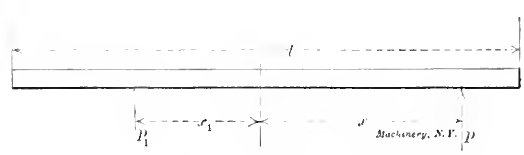
"Do not obscure a drawing by a lot of notes. Literature looks cheap on a drawing. The drawing should tell its own story without remarks, and the workman has a right to expect it. Besides, notes are a prolific source of error, as they tend to confuse or escape notice entirely."

There are many draftsmen—good ones, too—who will strongly disagree with Mr. Ranson over this rule. He tells them not to obscure a drawing by a lot of notes, and, of course, nothing *should* be done to any drawing to obscure it, but why should a few notes, properly made, on a drawing tend to confuse it. On the contrary, such notes may save much valuable time, if not costly mistakes. Again, a simple note may sometimes save making another view, which would contain nothing not shown on the others save some minor detail. Mr. Ranson evidently believes that a mechanical drawing should be a drawing and nothing more, but unfortunately (or fortunately) all men are not trained alike and do not think alike. What is plain to one is obscure to another. A drawing is not the end, but only a means to an end, being an illustrated direction for performing certain work. If a draftsman has reason to believe that a simple drawing is liable to be misunderstood, he should by all means make such notations on it that will prevent the mechanic going astray. The very fact that mechanical drawing is the "hand writing of mechanics" does not preclude the use of other hand writing if the first does not seem to fully fill the bill. Where a shop has a system of operation sheets giving the details of work of each piece the use of notes on the general drawings is unnecessary and should not be allowed, but this refinement of practice is one not found in the majority of shops.

* * *

THE LAW OF FRICTION.

A simple and beautiful experiment, illustrating the truth of the law that friction is proportional to the normal pressure between surfaces having a constant mutual coefficient, is described by a correspondent of *Engineering*. A meter stick, yard stick, or any straight rod, having a uniform section, completes the apparatus required. If such a stick be supported as a beam upon an outstretched finger of each hand, and the fingers be then moved inward toward the center of the rod, it will be observed that they invariably meet exactly at the center. A graduated rod facilitates the experiment by showing the successive stages of the movement, for it will be noticed that one or the other finger will make a temporary advance, but will then be overtaken by that farthest from the medial line of the rod. If l be the length of the rod, w the weight per unit of length, and x and x_1 be the distances of the fingers from the medial line at a given instant, then the moment equation about one end of the rod will be



$$\frac{w\,l^2}{2} = \left(\frac{l}{2} - x_1\right) p_1 + \left(\frac{l}{2} + x\right) p,$$

p_1 and p being the reactions at the supports, or $p_1 + p = w\,l$.

Hence, it follows that

$$p = w\,l \left(\frac{x_1}{x + x_1}\right)$$

$$p_1 = w\,l \left(\frac{x}{x + x_1}\right)$$

By multiplying each expression for the reactions by the coefficient of friction, the resistance to sliding at the supports is found; and it is clear that this is inversely as the distance of the support (finger) from the medial line of the stick. Sliding therefore takes place over that finger which is the more distant from the center upon the application of the force, and any inequality of distance is thus wiped out. Unless, therefore, the friction was directly proportional to the pressure, the resulting meeting of the fingers on the medial line of the stick would only be a chance occurrence.

* * *

Moisture in the cylinder of a gas engine is sometimes the cause of its refusal to start. This is only one of many things that make the gas engine considerable of a mystery to the uninitiated, and even the old-timer occasionally runs up against a proposition that gives him considerable puzzlement.

THE MANUFACTURE OF BELTING AT THE SCHIEREN FACTORY.

Although leather belting is one of the most common factory supplies, it is probable that few, even of those who operate belt-driven machinery every day of their lives, are familiar with the different steps of manufacture required to convert the hide into the finished product. At the plant of Charles A. Schieren & Co., New York, there is an especially favorable opportunity for observing the several processes, since this company occupy a new and modern building, which they have recently erected for their own use and for the use of other firms in the leather business, who rent such lofts or offices as are not required by the owners. It is a ten-story fireproof building, with all steel work protected by non-conducting covering. Power is furnished by an independent steam and electric plant, and the elevator service, facilities for shipping, the lighting, etc., are in accord with the most modern ideas for city buildings.

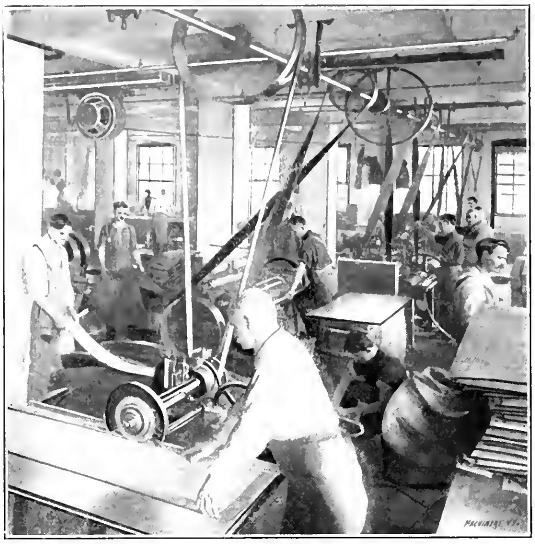


Fig. 1. The Cutting and Scarfing Machines.

The location of the building, on Ferry street, is in the section known as the "swamp," directly east of Post Office Square. In the early days of New York, when, as in other small towns, the inhabitants depended to a large extent upon products manufactured within the town limits, there were tanneries in the "swamp" district; and although these have long since ceased to exist, the leather business is still centered in this section and many of the wholesale leather houses and plants for the manufacture of leather goods are located there.

For the manufacture of high-grade leather belting only the butt portions of the hide are suitable, and this is the only part used for belts by this company. The flanks, shoulders and necks are sold for shoe leather. The butts are received in the basement, where the hides are cleaned and softened by washing in a large rotating tank containing water. They are then submitted to a scouring process, during which they are laid, one at a time, flesh side up, on a table where blunt reciprocating scrapers pass over the hide and squeeze out the water and dirt. The hide is then laid over a beam, the flesh side scraped by hand, and the pieces of soft leather not suitable for belting are removed. These pieces are not wasted, however, for they are sold and used for making a compressed leather that is employed for a variety of purposes, among them the heels of shoes. The final steps in the preparation of the hide are its treatment with oil on the grain side and tallow on the flesh side, to preserve the leather and make it pliable, and at last stretching and drying.

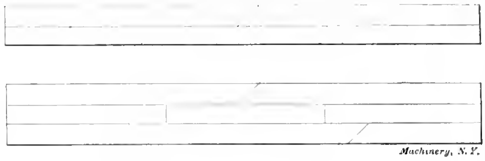


Fig. 3 Method of Making Joints.

The butts are carried from the basement to the sixth floor where the manufacturing begins. They are first put through cutting and scarfing machines, a view of which appears in Fig. 1. The cutting machines have a rotary knife like a circular saw without teeth, but the knife and its spindle are above the cutting table instead of below it. The leather is run under the knife, the width of the strips being gaged by guides and the strips then go to the scarfing machines, where the ends are shaved off on a bevel about three inches long for the joints. Before gluing the joints, however, the scarfed ends are finished to a fine edge by hand shaving, squared with the sides and matched for length. The scarfs are also scraped to remove any irregularities produced by the cutters of the scarfing machines.

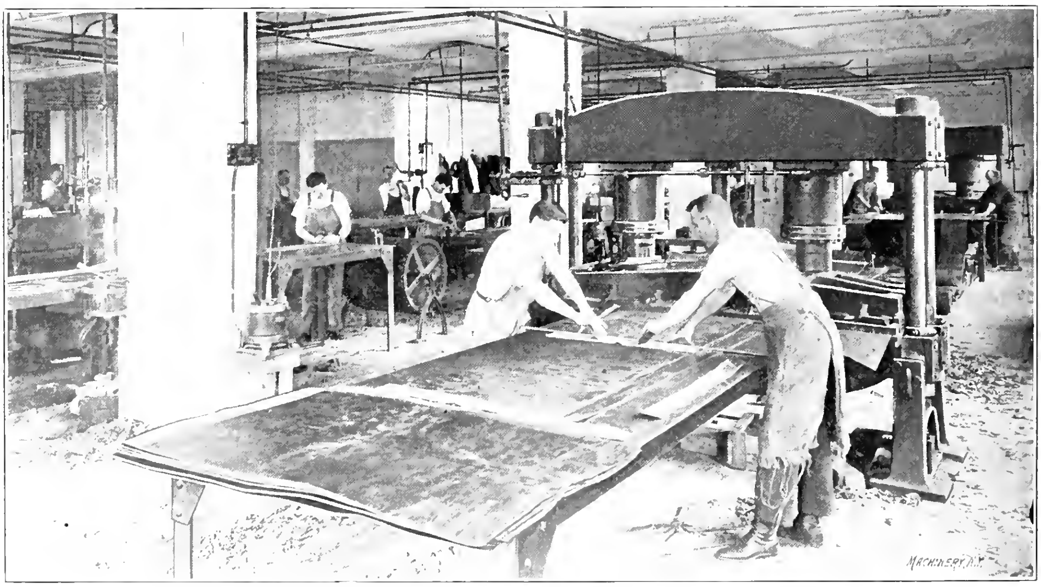


Fig. 2. Special Hydraulic Press for Building up and Cementing Belts.

The belts are built up and cemented on tables of Watson-

Stillman hydraulic presses made especially for this work. Fig. 2 shows one of the larger presses which has a table 8 feet wide and is designed for the largest belts used in textile mills or in dynamo driving. To insure a neat joint and a straight belt, great care is taken to bring the sides of the strips of belt to be glued in a straight line; and when this is done and the scarfs are bought to the correct position, a steel straightedge is placed on top of the lower belt, and

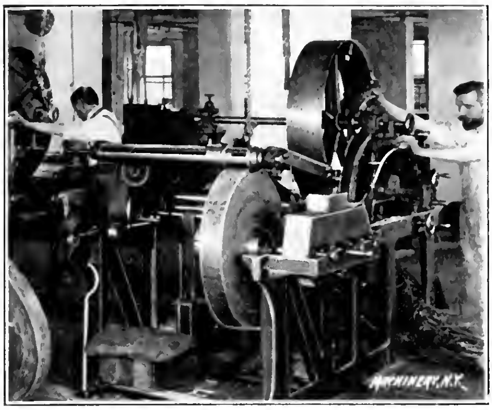


Fig. 4. The Finishing Machine.

against the end of the upper belt, which latter is then removed and the scarfed end of the lower belt is scraped off slightly up to the line of the straightedge, thus making an accurately formed seat for the bevel of the upper belt. This results in a joint with no ragged or projecting edges. In cementing, a stiff brush is used to rub the cement into the pores of the belt, only a small quantity of the adhesive being applied; and then the joint is placed under the press for several minutes while hydraulic pressure is applied and the cement allowed to set. When a belt 50 or more inches wide is required, parallel strips of leather must be joined together and this is done by butting the pieces longitudinally and allowing the two thicknesses of leather, or three thicknesses, according to whether it is a double or triple belt, to overlap and break joints as in Fig. 3.

After the required length of belt has been glued up it passes to the finishing machine. The belt is here drawn between stationary knives, which are set the required distance apart to trim the edges of the belt, rounding them slightly and making the belt of a uniform width. In its passage

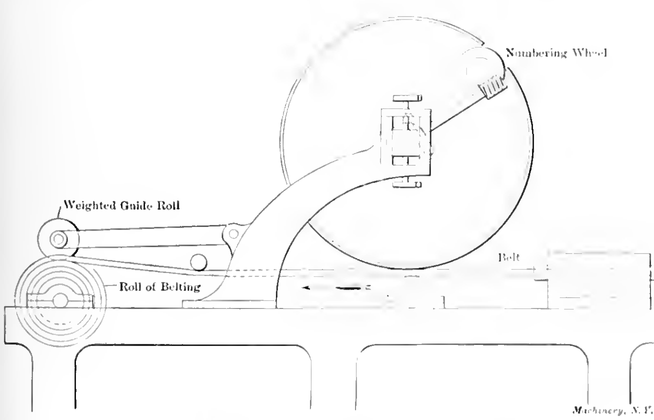


Fig. 5. Diagram showing Mechanism of Finishing Machine.

through this machine the belt is stretched and it also travels under a large wheel, in the rim of which is a numbering die; the circumference of the wheel is 10 feet, so that at each revolution a number is stamped on the belt, indicating its length in feet. The belt is finally coiled or wound on an arbor. In Figs. 4 and 5 are views of the finishing machine, which are self-explanatory. The arbor on which the belt is coiled is driven by a train of gearing and by this means the belt is drawn through the machine under tension.

Various kinds of belting are made to suit the requirements of customers. A belt with cemented lap joints is considered to be as strong at the joints as at any other point, but some customers prefer to have the joints riveted also. Certain brands of the highest grade double and triple belts are stitched lengthwise with heavy thread to render them doubly secure against pulling apart. The same object is also attained by screw fasteners. The screws are originally in the form of a threaded wire wound on a reel mounted on top of the hollow spindle of the machine that inserts the fasteners. The wire passes down through the center of the spindle and is gripped by a chuck at the lower end. As the spindle rotates the wire screws itself into the belt a predetermined distance, at which point it is cut off just beneath the surface of the belt by cutters or

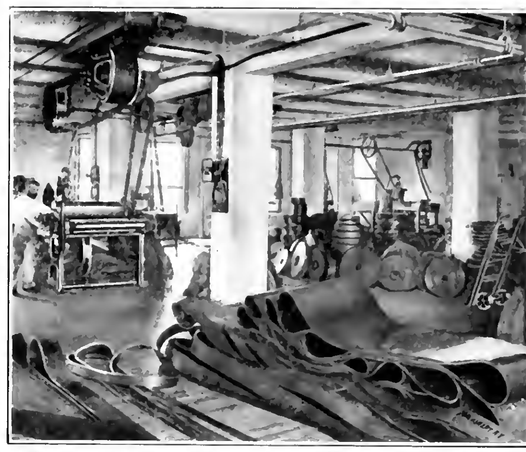


Fig. 6. General View of Finishing Room.

nippers controlled by the machine. Belts which run in damp or otherwise unfavorable locations must be made water and oil proof. Especially is this desirable in the case of belts for dynamos or other rapid-running machinery, where oil is likely to be thrown off the pulleys onto the belts. Link belts are manufactured here, round belts, braided rope belts, and other products of a like character.

The leather used by Charles A. Schieren & Co. comes from their own tannery at Bristol, Tenn. This is in the heart of the oak country, since oak-tanned leather should be exclusively used for a high-grade product like belting. The bark is stripped from the trees in the spring, when the sap begins to flow up into the trunk and limbs of the tree, and is stored in sheds where it seasons for future use. The hides, which come from the slaughter houses of the West, are washed in water to remove the dirt, then placed in vats of weak lime water for several days, until the hair has been loosened sufficiently to allow it to be scraped off with a blunt knife. The hides are then saturated by a neutralizing solution called "bate," which removes the lime, and then they are ready for tanning.

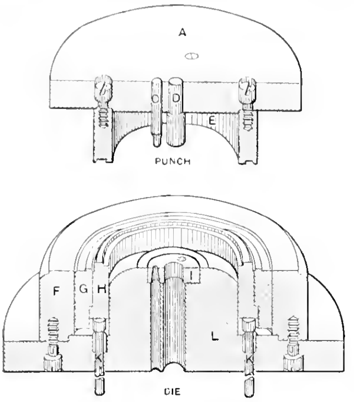
The bark is crushed and delivered to leach tubs, where moisture is applied by means of rotary brass sprinklers. The water filters through this mass, carrying down the tannic acid, which is collected and used in the tanning vats. The process of tanning requires in all a period of 120 days, after which the hides are oiled on the grain side, then hung up in a darkened loft, where they are kept at an even temperature and gain a clear russet color which characterizes leather prepared by this process. The leather is finished by shaving and scouring, part of this work being done at the tannery and the balance at the New York factory, as mentioned above.

CAN BOTTOM PUNCH AND DIE.

W. VAN ORMAN.

The accompanying illustrations show a punch and die for producing the can bottom shown in Fig. 3 at one operation. The die is of composite construction and is, I think, of somewhat novel design, being constructed differently from any other that I have seen.

The punch and die are shown in perspective and cross section in Fig. 1. The body of the die *L* is made of cast iron. The central portion is made the size of the raised or embossed part of the can bottom. The rings *G* and *H* are made of tool steel, while the outer ring *F* is of cast iron and is held to *L* by the fillister head screws *J*. It will be noticed that a small raised portion or flange is left on the piece *L* about 3/16 inch high for the purpose of centering the ring *F*. The ring *F* was made a driving fit on the flange so there is no chance for it to change its relative position with the remainder of the working parts of the die. The ring *H* might be called a combination forming and cushion ring, the desired form being cut into the face of the ring as shown. *G* is the cutting ring or die which trims off the metal from the can bottom after it is formed. The disk *I* is made of tool steel and it constitutes the piercing or perforating die for the four holes in the bottom. The part *A* of the upper half or punch part is made of cast iron while the other parts *C*, *D* and *E* are of tool steel. The ring *E* is turned the desired shape and size and, of course, the thickness of the metal used is taken into consideration. It is fastened to *A* by the screws *B* and in this case, also, a boss is turned on *A* over which the ring *E* is made a driving fit. This saves doweling to prevent the ring changing position.



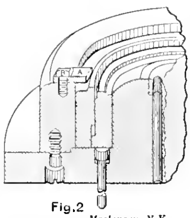


Fig.2

Machinery, N.Y.

Fig.1
Sectional and Perspective View of Punch and Die.

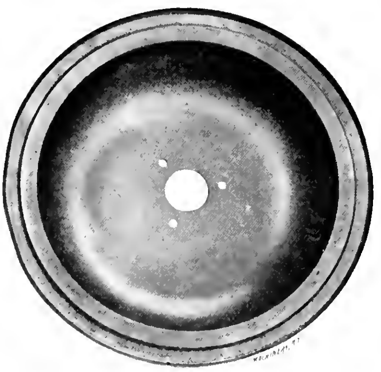


Fig. 3. The Completed Punching.

Fig. 1 shows the die before the piece is formed and illustrates the relations that the different parts bear to one another; Fig. 2 shows the die as it would appear after the piece is formed and before the ascent of the ram. It will be noticed that the ring *G* is counterbored at the bottom and that a corresponding flange is turned on the ring *H*; this construction will be explained later.

Before the sheet material is fed into the die it is cut into squares of 8½ inches across, which shape enables the operator to feed the die with more facility. After the die has been set up in the press and everything is in readiness the metal is placed upon the die between the gages *A* shown in Fig. 2, these being four in number. The press is then "stepped," and as the ram descends the metal is gripped between the punch *E* and the ring *H*. When within ⅛ inch from the bottom of the stroke the metal is cut or trimmed from the forming piece by the cutting ring *G* which is made ¼ inch longer than the ring *H* for the express purpose of trimming the metal before the form of the piece is completed. The ring *H* continues its descent until it bottoms, as shown in Fig. 2, and, as the piece at this moment has not received a complete form, there is just enough draw to the metal to pull it away from the outside and to allow of its being thrown down on the outside, as shown, which gives it a start, or to use other words, enables it to be worked to better satisfaction while being double seamed.

At the same time the piece is being formed the holes are punched by the four punches *C* and *D*, which are made just long enough to penetrate the metal. On the up stroke of the press the rings are forced back to their original places, by the cushion pins *K*, of which there are six all together. The ring *G* being counterbored, and with the ring *H* flanged to fit, it carries the ring *G* with it and the gages *A*, as shown in Fig. 2 also act as a stop for the ring *G*, and keep it from pulling out with the punch. These rings are all made a nice working fit, in their respective places, and the cutting ring *G* is hardened and ground to size.

Fig. 4. The Way the Product Looked before Air Holes were made in the Dies.

There must be air or vent holes drilled in this die for the escape of compressed air; otherwise the die will produce bad work. I show herewith, Fig. 4, a can bottom which came from the die before there were any air holes drilled and it will be plain to see the effect which air has upon the work. Fig. 3 shows a bottom formed by same tools after the air holes were provided.

* * *

EMERSON P. HARRIS ON TRADE JOURNALISM.

The concluding lecture of a series on similar subjects before the evening class at the West Side Y. M. C. A., New York City, was on the topic "Trade Journalism." Besides the members of the class, the trade papers and the advertising agencies were well represented in the audience. The speaker of the evening, Mr. Emerson P. Harris, holds a unique position in the publishing field; he is probably the only man living who has as his sole occupation the selling of trade papers on commission. This business he pursues, not only with considerable profit to himself, but with advantage to the publisher as well, because, before he undertook it, there was no established basis of value and a comparatively restricted market for trade publications; and the mere fact that one was for sale often invited suspicion of its value. Mr. Harris has therefore done for the trade publications what the Stock Exchange does for securities—he has created a market and established a basis of value which makes the sale of a legitimate trade publication no more difficult than the sale of a standard railway security.

Mr. Harris, in opening his remarks, referred to the fact that the trade or "technical" paper, as he preferred to call it, differs radically in one respect from any other branch of journalism. This point of difference is the unusual price per subscriber which the trade journal is able to command as an advertising medium for commodities within its field, and it may be laid to a number of reasons. For one thing, it speaks to a selected audience. When a stove polish manufacturer erects a billboard on the Jersey meadows, his sign is obtruded upon the unwilling passenger who is being hurried to his work, only half awake, perhaps, or is returning home hungry and tired after his day in the city. It is the hope of the advertiser that out of the many thousands who pass his sign daily, there may be some one in a receptive mood who will retain the name of his commodity and inquire for it when next he has occasion to buy supplies. On the other hand, the manufacturer who advertises in a trade journal has the assurance that the man who sees his advertisement is, first of all, interested in the goods there offered, else he would not have subscribed for the paper; second, this advertisement meets his eye at a time when he is interested in the subject, else he would not have the paper in his hands; third, the editorial and advertising pages in a technical paper are of necessity so correlated that the reader is put into a receptive frame of mind for whatever of novelty and excellence there may be in the product of the advertiser. In this last particular especially does the field under consideration differ from that of the popular weekly and monthly journals. In these papers the editor ofttimes gives considerable valuable space to pleading for "high thinking and low living," while the advertiser just as strenuously works for the doctrine of "high living and low thinking."

In judging as to the value of a given paper from the advertising standpoint, quite often the mere matter of size of subscription list bears little relation to its effectiveness. In this field the quality of the list is far more important than its size In some trades it is quite conceivable that, if the paper went into the hands of a certain 200 or 300 men, its advertising effectiveness would reach a maximum and any further increase in the list would be of no direct benefit to the man with goods to sell. The true way, then, to express the value of a paper as an advertising medium is by stating it in terms of percentage of ground covered. Mr. Harris suggested that it would not be entirely beside the mark for an advertiser to ask that he be allowed to examine the subscription lists of a paper to determine what percentage of the men he desired to reach were there represented. Some efforts in this direction have been made by one large advertiser, at least.

The speaker was occasionally interrupted by questions from his audience. In fact, the latter part of the allotted time was entirely taken up in this way. A great number of points were covered. In answer to a question as to the relative standing of American and foreign engineering papers, the speaker gave it as his opinion that the English and continental journals are exceptionally good in the field of general engineering, but are not specialized to anything like the degree that they are in this country. This makes them inferior as advertising mediums, since their subscription list is thus not so rigidly confined to those interested in a given business.

Another question related to the comparative importance of the advertising and editorial departments of the paper. The speaker considered that this question was in a way beside the mark. One might as well discuss the question of the relative importance of the heart and the brain. An intelligent and progressive editorial policy gives a paper the standing which makes it a good advertising medium, while the advertising, in turn, makes it possible to keep up or raise the standard of the editorial department. One of the advertising men present briefly referred to the way in which the editorial policy of a journal affects the interest of the advertiser, giving, as examples, the names of certain publications which he would recommend to his clients simply from the standing which the excellence and intelligence of the matter in the reading columns had given them.

Mr. Harris described some of the difficulties the editor has to contend with. One of these is the tendency to secretiveness on the part of those who are possessed of information and material which would make readable copy. Another is the continued and persistent temptation which is always with him to yield to the pressure for notices and write-ups in the reading pages of the paper. This temptation is especially insidious from the fact that no line can be drawn between matter which is primarily of interest and novelty to the reader, which yet incidentally serves as an advertisement to the manufacturer concerned, and matter which is boldly and openly an editorial advertisement. Within the first class mentioned, and bordering on the second, lies the greater part of the material available for publication in the reading pages, and the judgment and firmness of the editor has constantly to be exercised to preserve the integrity of his department. Considering the temptations to which he is subjected, Mr. Harris kindly volunteered the opinion that the editor of a trade paper who adheres to an honorable and intelligent editorial policy, is possessed of a rugged and well-tried virtue, rather than the merely negative quality of innocence, which might characterize a man whose calling is less beset with specious allurements.

* * *

A WOULD-BE WATCHMAN'S APPLICATION FOR A JOB.

———Jct., August 12, 1905.

——— —— ——— —— Co., Chicago, U.S.A.

Dear Gentlemen:—I see by the Globe paper where you's have purchased eight acres on the west side of the G. T. R. tracks in the city limits, not far from the Jct limits, knowing the place well. I see that you's are making preparations to build large shops for Mfging. I will offer my service as night-watchman to you's when you are ready. I am a young man single 29 yrs of age, 5′ 6″ height, weight 150 lbs, strict & temperate free from chewing, drinking & smoking. Born and raised on a farm, 60 miles from the Jct., northwest with in 32 miles from Collingwood, there were three brothers of us and my father for the 100 acre of land and there was not enough of work for all of us, and I went threashing with a man, I done the firing and running of the engine I followed this up 5 yrs, an then I purchased a out fit for myself. A traction engine and separator, turn a round an sold the separator to a nother man that broke his own, an I kept my 18 h. p. engine and I went around cutting feed & choping grain & cutting wood with a circular saw. Then the man that bought my separator bought a clover separator & got me with my engine to go an threash clover in the fall an all winter and right up till the snow went in the spring. I followed this up for 3 yrs more & sold out. Since this my father died, an my youngest brother he went to the west & took up land there & I rented the farm to my 2nd youngest brother. An I moved my Mother & Sister to the Jct & we bought a lot & built a house on ——— Ave., No. 94 ——— Jct. to live privite. For references I can give you 35 or 40 names of good men that knows what I am. I will take $675. a year for 10 hrs. a nignt Or $750 or $725 a year for 13 hrs. a night. My idea on night watching is this A night-watchman should go on duty 1 hr. before a factory shuts down for the night, the reason is this, he is making his first trip through the factory & he can have an eye on the employees & see how they leave things when they are going out or catch them in the act of lighting their pipes, as some does when they are leaving the shops & throwing the match down thinking that they have blown it out. It is nothing but right down carelessness of men & night-watch men that causes all those big fires in factories. I often ask people what do they engage nightwatchmen for, they say to watch buildings in case of fires might start, and I have said to them what do they let the fires start for, & they would say that the nightwatch-man was not doing his duty when he would let a fire start. I'll ask you's to equiped your factory with electric registry system connecting with the detective department at the city Hall. A good night-watch-man is a man *that will do his duty*.

Yours Truly,

——— —— ———.

* * *

Don't forget that a lathe tool is liable to draw into the work if it is set below the center for external work; with internal work the danger is when it is above the center.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MAY, 1906.

PAID CIRCULATION FOR APRIL, 1906,—22,311 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE ENTERING WEDGE.

Last December Representative Littauer introduced the following bill in Congress "to fix the standard of weights and measures by the adoption of the metric system of weights and measures":

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the first of July, nineteen hundred and eight, all of the departments of the government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system."

All the space devoted to reading in this number of MACHINERY would not be sufficient to print more than a fraction of the arguments for and against the introduction of the system in this country, and we shall not undertake it. We are opposed to its introduction because, while the metric system undoubtedly possesses features of great theoretical convenience in experimental and laboratory work, it has no such advantages in manufacturing, and in some respects is inferior to the present system of measurement, as we have from time to time made clear. Its adoption would mean an expense of thousands of dollars and months of work in almost every large plant, to recast drawings and change the present system of gages, etc., which would unquestionably result in great confusion and loss of time, both to employers and employees.

The machinery manufacturers of this country are practically a unit against it. It is possible that these men are lacking in enterprise and blind to their own interests, as the metric advocates claim; but among them are many manufacturers who for years have made a study of Continental methods, and their unanimous opinion that the adoption of the metric system would not facilitate their work should carry more weight than that of the foreign engineers who are showing so much anxiety lest America should "find herself isolated and left behind" in the race for commercial supremacy.

The bill referred to appears to be mainly supported by theorists who have little or nothing to lose by the change, while its opponents are all manufacturers who would be put to heavy expense and their business disturbed. It is an apparently innocent piece of legislation, by which the use of the metric system is required only in the government departments; but this is believed to be the entering wedge to force the adoption of that system in this country, and our machinery interests do not want it.

THE SNOUT BORING MACHINE.

There are certain principles of machine design that do not seem to be fully understood, or if understood are not appreciated as they should be. One of the most important is that no matter how strong and rigid a machine is built it must necessarily be displaced in its working parts to some extent, but deflection is not necessarily productive of inaccuracy provided the amount of deflection is uniform throughout the course of a machining operation. For example every mechanic knows that it is possible to produce a true bored hole with a slender boring tool held in a lathe tool post, provided he takes the necessary time and precaution in grinding the tool, etc. The tool may be so slender that it is easily sprung out of place by the hand but the deflection is practically the same at all points of its travel while boring the hole. If the attempt is made to support the boring tool in a bushing so as to make it very stiff at the beginning of the operation the result, of course, will be a tapered hole for, as the cutting edge of the tool travels away from the bushing, it will be deflected more and more by the pressure of the cut.

After these preliminary remarks we wish to call attention to the principle of the snout boring machine which is a tool that has attracted very little attention in this country, although used in some British and European shops. The principle of its construction is simple, being essentially embodied in a table on which the cylinder is mounted and an overhanging arm carrying at its extremity a boring head, the bar or driving shaft being supported in the arm. The length of the overhanging arm is such as to cover the length of the hole to be bored, the cylinder and table being fed longitudinally as the cut proceeds. While the rig is not of the stiffest possible construction, being unsupported at the outer end of the arm, its deflection is uniform at all points of the cylinder bore for the same pressure of cut. Hence a roughing and finishing cut always suffices to make a hole with parallel sides. Cylinders with one end solid are bored with the same facility as when both ends are open and for this reason this type of boring machine is one that is particularly adapted to the manufacture of gas engine cylinders. Some of the builders of vertical gas engines are using this form of boring machine, in which case they are able to avoid the use of a screwed top head. But many of the manufacturers are using boring bars supported at both ends which necessitates a hole through the top head in which a screwed head is inserted when the cylinder is erected. This construction means extra cost and adds practically nothing to the value of the engine.

* * *

An editorial note appeared in the April issue on the choosing of a firm name, mentioning the more or less obvious fact that a firm name should indicate both the place and the character of the business, if possible. Then the matter of remembering firms and their locations is simplified. In this connection we would also suggest that it is not a very good practice for a firm to give a distinctive trademark name to a machine as, for example, the "Sun" boring mill or the "Atlas" shaper. We have received from time to time inquiries for the names of tools or machines bearing such trademark names, and when, as often occurs, the makers have ceased advertising these tools, it requires either a good memory or a lot of looking up to discover by whom and where the machine was manufactured. In our opinion it is far preferable that a machine be known as the "Brown & Smith" lathe than to give it a fancy name which means nothing and does not even have the merit of locating it, except as the advertising may have associated the trademark name and the firm together. Of course there are certain products which are preferably distinguished by some name as, perhaps, is the case with tool steels. There are, as everybody knows who uses tool steels, a great variety of fancy names of more or less catchy form used to distinguish the different brands, but the same trouble occurs with them, for people remember the brand long after the name of the maker is forgotten. We have been to considerable trouble in "running to earth" the makers of certain brands and have consequently compiled a list of the makers and trademark names of tool steels, so as to be in a position to readily give such information to those desiring it.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Consul-General Skinner, of Marseilles, writes that the official decree has been published by the president of the French Republic providing for prizes for the following inventions: One prize of 20,000 francs ($3,860) is instituted for the benefit of the person who shall discover a denaturizing agent for alcohol more advantageous than the denaturizing agent now in use, and offering to the "treasury" every guarantee against fraud. One prize of 50,000 francs ($9,650) is provided for the benefit of the person who shall discover a system of utilizing alcohol for illuminating purposes under the same conditions as petroleum.

In a paper, "Gas, Oil and Petrol Engines," read by Mr. Henry N. Bickerton before the Manchester Association of Engineers, March 10, 1906, the statement was made, in reference to the Diesel oil engine, that a test conducted by Mr. Michael Longridge on a three-cylinder inverted vertical 500 H. P. engine of this type showed an oil consumption of only 0.451 pound of Galacia crude petroleum per brake horse power hour. This oil cost about 0.87 cent per pound (£4 per ton of 2,240 pounds) delivered at the power plant. Hence, the cost per brake horse power hour for fuel was only 0.381 cent, or $1.95 per hour for the full power of the 500 H. P. unit.

The copying of illustrations or printed matter by photography is a rather expensive and tedious task when done in the ordinary manner. A contributor to a German publication, according to a note in the *English Mechanic*, suggests a much cheaper and simpler plan. The page or cut to be copied is laid on a table and above it, at an angle of about 45 degrees, is placed a common mirror. The reflection of the matter to be copied in the mirror is focused on the ground glass of the camera, but then instead of using a plate a smooth-faced bromide or negative paper is used for the exposure. The result of course is white letters or lines on a black ground, but this ordinarily is not objectionable. The use of the mirror is necessary to reverse the view which otherwise would be wrong side to.

The oxy-acetylene blowpipe produces a very high temperature, being in the neighborhood of 4,000 degrees C. It promises to be a very valuable means of welding plates together and for other purposes requiring high temperature. The proportion of oxygen and acetylene may be regulated so as to make the flame either an oxidizing or reducing agent simply by giving excess of oxygen or acetylene as may be desired. One great advantage of the new blowpipe is that both oxygen and acetylene gases may be generated as desired thus doing away with the necessity of transporting them in cylinders under high pressure. The acetylene gas is of course generated by the combination of water and carbide of calcium, and oxygen may now be produced by the combination of water and peroxide of sodium which is sold under the trade name of "oxone."

The largest steel ingot hitherto produced was cast last February at the Manchester works of Armstrong, Whitworth & Co., says the *Engineering Review*. This ingot with the weight of 120 tons was made in accordance with the Whitworth fluid pressure system, the molten metal being poured into a mould itself weighing about 180 tons, which was then placed beneath a hydraulic press having a 6-foot diameter ram working at a pressure of 3 tons per square inch. The ingot is intended for the turbines of the new Cunard liner which will develop 70,000 horse power. It is interesting to compare this enormous body of solid metal with the tiny blooms of some three-quarters of a hundredweight which represented the maximum weight of wrought iron producible in a single mass by ironworks half a century ago.

In the discussion of the paper, "The Behavior of Materials of Construction Under Pure Shear," which was presented before the January meeting of the Institute of Mechanical Engineers, reference was made to the well-known phenomenon of there being less metal in a punching from a thick boiler plate than volume in the hole made. Mr. W. H. Maw said that he had ascertained the specific gravity of a number of such punchings and found them to be practically the same as the boiler plate; what slight difference there was indicated that the specific gravity, if anything, was slightly *less* than the plate. His observation was that the metal was displaced into the plate surrounding the hole, thus thickening it to a slight extent in a narrow ring around the hole. Prof. Unwin corroborated Mr. Maw's observation, both as to decreased volume and slightly decreased specific gravity. This decrease of volume is, of course, much more noticeable on thick plates than on thin plates; in fact, with thin plates it does not exist to any appreciable extent.

The Carnegie Steel Co. has just closed a contract with the Commercial National Bank, of Chicago, for the construction of the largest armor plate safety deposit vault in the world, says the *Iron Trade Review*. It will be 46 feet square and nine feet high and the material to be used is the nickel steel Harveyized face-hardened steel identical with that used by the United States government to protect its battleships and cruisers. In addition to this immense safety deposit vault the Carnegie Steel Co. will build for the same company a cash bank vault with interior dimensions 36 feet, by 17 feet by 9 feet high. With the construction of the vestibule to the vaults particular care has been taken, and this vestibule will be 10 feet square, walls eight inches thick, and the door jambs 14 inches thick, forged from one solid ingot of armor plate weighing about thirty tons. The doors at the main entrance will be eight feet in diameter, twenty-one inches thick, and will weigh seventeen tons. The inner doors will be four and one-half inches thick fitted with bolted mechanism controlled by double dial combination locks.

The use of the nickel steel alloy "invar" for shop standard gages has been initiated in Great Britain by W. F. Stanley & Co., London. This useful alloy, as has been mentioned in MACHINERY, is practically unchangeable in any of its dimensions for ordinary changes of temperature, the coefficient being under 0.0000001 per degree F. We have mentioned the use of invar in geodetic survey work for the construction of instruments, and it has been used to a limited extent for measuring tapes although rather soft for this purpose. As to its use in the shop for standard gages there has been some difference of opinion as to the advisability of using a non-changing metal, the argument being that the metal composing a gage should have practically the same expansion coefficient as the metal being measured. On the other hand, however, we know that the gage being handled by the workman is almost always at a higher temperature than the work and, therefore, is more affected by expansion. If the gage were made of a "non-changing" metal, standardized at the average shop temperature, then no matter how much the gage is handled it should register accurately when used under ordinary shop conditions.

The difference between the action of spur gearing and worm gearing has been aptly expressed by stating that the first is an example of lever action while the second is that of wedge action. In the one case friction is present to only a slight degree while in the second case it may be the principal retarding factor. In the discussion of the paper, "Worm Contact," by Mr. Robert A. Bruce, presented before the January, 1906, meeting of the Institute of Mechanical Engineers the difference between the sliding action was pointed out, taking for example a spur gear of, say, 1½-inch pitch, and a worm gear of the same pitch and of the ordinary proportions used in practice. In the case of the spur gear the sliding movement would probably be not much more than ¼-inch for a certain

case, while with the worm gear it would be, say, about 3 feet. It is, therefore, much more important that the bearing parts be liberally proportioned than with spur gears. Whatever metals are used, the pressure must not be so great that the oil will be squeezed out; if the surfaces are well proportioned the worm gear will give a good account of itself. In short, worm gears must have much larger surfaces in proportion to the power to be transmitted than spur gears, whereas the tendency has been to make the proportions about the same.

"Forced draft," said Admiral Melville in a recent paper, "dates back to Stevens' Rocket, and its first use for marine purposes was by Mr. Robert L. Stevens on the Hudson River steamers in our own country prior to the Civil War. During that war Mr. Isherwood built a number of gunboats which used forced draft, but it had fallen into disuse for naval vessels until about 1882, when it was introduced into the English navy and still later was applied in the merchant service. In naval machinery forced draft has been of the greatest possible importance, because it has reduced boiler weights probably almost one-half. In the navy the natural limitations as to space and weight prevent the use of forced draft with very much economy of fuel. It is obvious that if the rate of combustion is increased from 15 pounds of coal per square foot of grate to 40 pounds, there ought to be an attendant increase of heating surface. In the merchant service, or at least in certain classes of vessels in that service, it is possible to do this, and in one of my annual reports I made a comparison between the boilers of a merchant vessel called the *Iona* and those of the *Baltimore*. In the *Iona* there were 75 feet of heating surface for 1 of grate, while in the *Baltimore* the ratio was about 30 to 1; but had the *Baltimore's* boilers been designed with any such ratio, their weight would have been almost double the weight of all the machinery of that vessel as actually built."

It is not an uncommon thing for a mechanical or electrical idea to be partially developed and then laid aside as being undesirable or even impractical for the time being. Mr. Frank J. Sprague claims that the inter-pole electric motor is an example, and designates it as the reincarnation of the electrical idea in a contribution of his to the *Electrical World*, February 24, 1906. The reason for Mr. Sprague calling attention to this revival of a so-called old idea is a statement made by him some weeks ago that heavy electric operations such as are required for railway trains under a motor potential of not less than 1,500 volts are quite possible and practical; he believes that the inter-pole motor points the way to the design of generators and motors which will work safely and efficiently at what is now considered extremely high voltage for direct current apparatus. The inter-poles being excited with series coils weaken and strengthen with the load and automatically work the same effect as shifting the brushes does with the simple form of motor. In this connection he refers to his United States patents No. 428,732, May 27, 1890; No. 324,891, August 25, 1885; No. 335,781, February 9, 1886, which he claims anticipated the present construction. Whatever may be the status of the patents on inter-pole motors, the fact is that the design is very successful. It makes the variable speed motor a great success and will no doubt greatly simplify the design of certain machines which now require considerable gearing to give the necessary speed variation.

Electromagnetic guns have repeatedly been proposed, says *Engineering*. A few years ago Professor Birkeland, of Christiania, whose name has become widely known by his successful fixation of the atmospheric nitrogen, actually experimented with model guns of this type. In the *Mitteilungen über Gegenstände des Artillerie und Geniewesens*, Captain A. Spacil, of the Austrian Artillery, deals at some length with the energy problem of such devices for steel and iron projectiles. He concludes that to impart a muzzle velocity of 1,640 feet per second to a projectile of 88 pounds, to be shot from a 43-calibre 5.9-inch gun, would require 600 coils of 7,216,000 feet of 0.059-inch copper wire, weighing 9,250 pounds, and at 181 volts per coil, a current energy of 54,300 kilowatts. These figures are of the same order as those which Birkeland gave for his gun, which was to hurl projectiles of 4,400 pounds with a velocity of 1,000 feet per second; he wanted 1,620,000 kilowatts (2,170,800 H.P.) at 3,000 volts. There is no power station in existence which could produce anything like this energy. Considering, however, that the energy would be required only for a fraction of a second, special machines might be devised for the purpose. Birkeland suggested that the primary generator should consist of a powerful electromagnet which was to be shot, by explosive power, through coils wound round a copper tube. He thus proposed to start from explosive energy in order to obtain, after three conversions, electromagnetic energy for the propulsion of projectiles. The efficiency of such combinations could not be but very low.

Mr. A. M. Mattice, at the December meeting of the A. S. M. E., in the discussion on "Bearings" objected to the drop by drop system of oiling. It tends to niggardliness in the supply of oil and actually induces waste, since the oil is liable to be burned and practically useless after going through the bearing once. For surface working under severe conditions the forced-oil system may be used to good advantage. It has the disadvantage of depending on a pump, which may fail to operate at the most critical moment. The proper method for most conditions is to lubricate all important bearings by the flooding system from a reservoir of sufficient capacity, located high enough to give a few feet head to the oil supply. This oil may be used over and over again, does not get dirty, and serves to carry away the heat generated by friction, as well as to lubricate the bearing surfaces. Mr. Mattice gave a number of examples showing the economy of this method of oiling. The steamer *Alexandria*, of Liverpool, driven by three turbines whose main bearings are oiled by this system, used in a season of four or five months only one barrel of oil. One turbine and generator of 1,000 kilowatts capacity averaged about half a gallon per week oil consumption.

The speaker also referred to the fact that bearings may be run continuously at much higher temperatures than common practice admits. This common practice he considered to be a prejudice dating from the time when vegetable and animal oils were exclusively used. With modern mineral lubricants a bearing temperature of 130 to 150 degrees F. is perfectly safe, and in one case an engine ran constantly month after month with a bearing temperature of 180 degrees without the slightest distress.

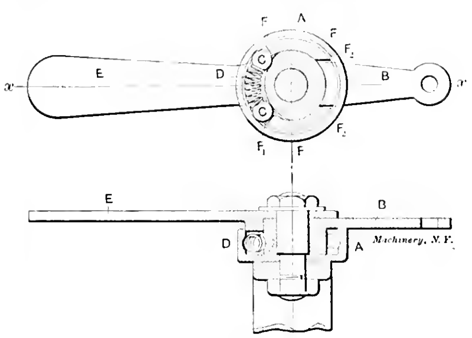
GASOLINE VS. DENATURIZED ALCOHOL.

In the hearing given by the Committee of Ways and Means of the House of Representatives on the subject of untaxed denaturized alcohol, Mr. Leonard B. Goebbels, representing the Otto Gas Engine Works, of Philadelphia, spoke interestingly on the gasoline engine and the dwarfing effect that the scarcity of gasoline is having upon this motor industry in the United States. He stated that owing to the rapidly increasing cost of gasoline, the use of it is now restricted to the smaller engines, say up to 30 horse power. In Germany, however, the building and selling of alcohol engines in the larger sizes is rapidly increasing because of the cheapness of this fuel when untaxed. Alcohol may be used the same as gasoline in engines designed for gasoline. For a given cylinder capacity an average of about 20 per cent more power is developed with alcohol than with gasoline. This is due to the fact that alcohol gives a higher thermodynamic efficiency than gasoline, although its heating value per volume is only about as 1 to 1.6; the thermal efficiency is about 21 per cent for gasoline as against 30 per cent or more for alcohol. A feature of the alcohol engine that will be appreciated by those who have suffered from the vile fumes discharged by gasoline engines when working badly is that the exhaust gases from alcohol are practically odorless; aside from being oderless they contain 20 per cent less of obnoxious constituents than gasoline. This is particularly valuable where motors have to be used in mines or other places where ventilation is imperfect. Again, alcohol is much less dangerous than gasoline; in fact there is little or no danger of explosion with alcohol. A test was mentioned in which a surface of 6 inches square was covered with equal volumes of gasoline and al-

cohol. The alcohol took twice as long to evaporate. A small quantity of gasoline was placed in a receiver in an iron bucket and tried for explosive effect. At the end of half an hour the bucket was filled with an explosive mixture so that a lighted match dropped in the bucket caused explosion. The same experiment tried with alcohol failed entirely, although it was allowed to stand a much longer time.

NOVEL LEVER LOCK.

The accompanying cuts, taken from the *Engineering Review*, show an English lever lock which is being exploited by the Finchley Motor & Engineering Co., Finchley, England. The principle of the device is such that the hand lever E may be readily shifted but the operated mechanism connected to B is always securely locked in position the same as is the case with a worm and wormwheel. In fact the device offers a reliable substitute for the worm and wormwheel without the loss of mechanical efficiency generally resulting from the use of such a device. The upper cut shows the plan and the lower one the side section of the device applied to the throttle or ignition adjustment of an internal combustion engine. The lever B may be set in any position within the limits of its movement by the manipulation of the hand lever E, but as soon as the latter is released the lever B is locked. The locking device consists of two balls C lying in an annular space formed between the locking lever B and the case or cup A. This space it will be observed diminishes in width from the center line $x\,x$ outwards in both directions, and the balls are separated



Novel Lever Lock.

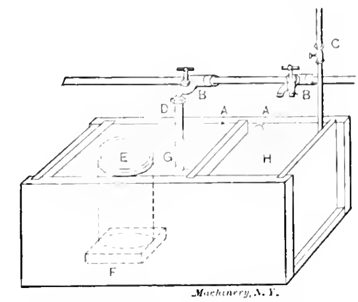
by the spring D which pushes them apart and keeps them in close contact with the interior surface of the cup and the exterior cam surface of the lever B, locking the latter securely in place. The operating lever E is mounted on the same axis with lever B and has two lugs F whose faces F_1 closely approach the balls in the locked position. When the lever E is shifted in either direction it loosens the ball which comes into contact with the lug and further movement brings the face F_2 of the opposite lug in contact with the side of lever B and moves it approximately through the same angular distance as E. Movement of the operating lever E in the opposite direction accomplishes the same result. The moment the actuating force is relieved from E the spring pushes the balls tightly into the tapering portions of the recess and so locks the lever B immovably in the cup A.

BRIGHT DIP FOR BRASS CASTINGS.

What is known to the trade as bright dip is absolutely indispensable in the manufacture of brass goods; this dip will be found in connection with every brass foundry, large or small, and has been in use a great many years, Mr. H. J. Hawkins says in the *Foundry*. It has never been improved upon as far as the results are concerned, but it is always found a very disagreeable and unhealthy solution to work over, and where it is required to dip large quantities of work special facilities should be arranged to carry off the fumes.

Where first-class work is expected and required it is of the utmost importance to have the dipping arrangements as nearly perfect as may be. A very simple and convenient arrangement for acid dipping is shown in the cut. The tank should be made of good pine, free from knots, or oak, and well bolted. Line the cold-water compartment G with asphaltum inside, and the whole tank should be well pitched on the outside, leaving the inside of part H to contain the hot water free from pitch. The clean water should be carried to bottom of tank by means of hose D, allowing the dirty water to be carried off by the discharge pipe A, the top of which should be about four inches below the top of tank. A wooden hood should be built over this tank to carry off the fumes. The water in H is heated by steam from the pipe C.

The standard formula for the bright dip for brass work is as follows: Sulphuric acid, 4 gallons; nitric acid, 2 gallons, stirring in a small handful of salt, using a glass rod for stirring. Sometimes an ounce or two of lampblack is added to



Tank Arrangement for Brass Bright Dip.

this dip with beneficial results seen in the finish obtained on the work. This dip should be kept as free from water as possible, as water weakens it and causes it to lose its activity. It is the general practice in dipping brass castings to dip them directly from the cold water into the acid dip. This is wrong; the work should go into the bright dip dry, or nearly so. It is the best method to run the work through the hot water in H, shake off, then into the bright dip in E. In this way the work will go into the dip dry, or nearly so, thereby increasing the life of the dip. Some work, especially new castings, must be dipped twice and often three times, where a fine even color is required. After dipping, rinse quickly in cold, then hot water, and dry in sawdust, using "hardwood sawdust."

UNTAXED DENATURIZED ALCOHOL.

Statement of Hon. James Wilson, Secretary of Agriculture, before the Committee of Ways and Means, House of Representatives, February 7, 1906.

The question of heating and lighting on the farm is becoming quite insistent. In the prairie countries there is some coal, but the readily obtained supply will become exhausted before a very remote date. Hard coal taken out to the prairies is expensive at all times, and very expensive quite often; besides which, it is becoming more and more expensive as time goes on, so that we must begin looking about for other sources of heating and lighting. The starch and sugar plants are the present source of alcohol and will continue to be. In Europe the chief sources of alcohol have been the potato and the sugar beet by distillation, either directly or from their by-products. Other sources of alcohol which may be advantageously utilized in the United States are the white potato of the North, the sweet potato, the yam, the cassava plant, waste molasses from the sugar cane, waste molasses from the sugar beet, and the waste product from the stalk of the indian corn at the time of the hardening of the grain. In this list may be included all plants that yield heavily of starch or sugar.

The term alcohol as I am using it does not apply to any alcoholic beverage, but to pure or denaturized alcohol in a form suitable for technical uses and so mixed with other ingredients that it cannot be used as a beverage. Sugar and starch, on fermentation, yield about half their weight as absolute alcohol. In practice a smaller quantity is obtained because of certain by-products, such as acids, which are produced during the fermentation of sugar and starch. Practically it may be said that 45 per cent of the raw material—that is, the sugar or starch—is obtained as alcohol.

It is becoming an interesting question in what direction the

people will turn for heating and lighting, considering the increasing price of coal and the diminishing supplies of wood. An acre of land which produces 50 bushels of corn, nearly 2,800 pounds, will furnish 1,960 pounds of fermentable matter; that is, starch and sugar together. Forty-five per cent of this will be obtained as absolute alcohol, namely, 882 pounds. A gallon of absolute alcohol weighs 6.8 pounds; therefore an acre of corn would produce about 130 gallons of absolute alcohol. Commercial alcohol is about 95 per cent pure, so that approximately an acre of indian corn producing 50 bushels would make about 140 gallons of commercial alcohol.

If we assume the average crop of potatoes to be 300 bushels, or 18,000 pounds, it would produce 3,600 pounds of fermentable matter, since the potato contains an average of 20 per cent of this material. This would produce 1,620 pounds of absolute alcohol, or about 255 gallons of commercial alcohol, showing that an acre of potatoes produces much more alcohol than an acre of corn.

But there is another consideration with regard to the potato as a source of alcohol. We raise potatoes for human food, and for scarcely any other purpose. We plant the potato that has the finest flavor for the table, independent of its yield per acre. Were we raising potatoes for the purpose of making alcohol, these considerations would not be regarded. The variety of potato that would give the largest yield per acre would be planted. Where potatoes are used as cattle food, as they are in many foreign countries, varieties of this kind are resorted to, and there would be no difficulty whatever in doubling the 255 gallons per acre receivable from the present average yield of potatoes. So that it would be within bounds to say that 500 gallons of alcohol can be had from an acre of potatoes.

Potatoes, moreover, are a commercial crop only when within a certain distance of market. At the average price at which the potato sells it can be hauled only a short distance, but when looking to it as a source of heating and lighting, factories would be erected in country neighborhoods, and the potato would then be grown for its largest possible yield of alcohol. The sweet potato and the yam contain about the same quantity of fermentable matter and would yield equivalent quantities of alcohol.

So, looking at this subject from the agricultural standpoint, we find that the Northern States could readily depend upon the white potato as a source of heat and light, the Southern States upon the yam and the sweet potato, and the Western States upon the sugar beet. The extensive irrigation projects now being carried on by the United States government will result in watering lands that will produce sugar beets more profitably, perhaps, than any other crop. The molasses can be readily turned into alcohol.

The stalks of Indian corn, at the time when the grain is sufficiently hardened to be perfectly sound, when harvested contain a large quantity of starch. If the stalks of Indian corn could be utilized at that time for the manufacture of alcohol, they would produce a quantity which would be almost incredibly large. There would be approximately 10 tons of stalks to the acre of Indian corn yielding 50 bushels the acre, or 20,000 pounds, and of this at least 12 per cent, or nearly 2,400 pounds, is fermentable matter, 45 per cent of which can be recovered as alcohol, equivalent to 1,080 pounds of absolute alcohol, or approximately 170 gallons of commercial alcohol. The average yield of Indian corn is only about one-half the above, but the heavier corn lands of the country that would be used for growing corn for alcohol average easily 50 bushels to the acre. It is safe to say that the average amount of sugar and starch which goes to waste in the stalks of Indian corn annually would make 100 gallons of commercial alcohol per acre. When we consider the vast number of acres cultivated in Indian corn, approximating 100,000,000, it is seen that the quantity of alcohol that is lost in the stalks is so large as to be almost beyond the grasp of our conception.

Of course, it must be remembered that there would be very great difficulties attending the saving of these stalks and the manufacture of alcohol from them, and as long as there are cheaper sources it is evident that they will not be utilized for this purpose. But the time is doubtless coming when technical and commercial skill will be able to utilize this immense source of energy. Our coal mines are definite quantities and are being rapidly used up. Our forests are disappearing and many of them have disappeared. The same is true of the sources of mineral oil and natural gas. In the future—it may be some time in the future—the time will certainly come when the world will have to look to agriculture for the production of its fuel, its light, and its motive power. It seems to me that through the medium of alcohol agriculture can furnish in the most convenient form for the use of man this absolutely necessary source of supply. I believe, therefore, that the utilization of alcohol in the arts and industries, under such restrictions as would safeguard the fiscal rights of the United States Government, would prove not only a great stimulus to manufactures, but a great benefit to agriculture.

SOME TURBINE FALLACIES.

R. M. Neilson, in Power, March, 1906.

Although steam turbines are now much better understood by engineers in general than was the case a few years ago, there are still many prevalent fallacies concerning them and much ignorance on certain points in their theory of action.

Turbines were first used for the propulsion of ships in Great Britain, where they were employed first on the *Turbinia*, which was an experimental vessel built on the lines of a torpedo boat, and then on the destroyers *Viper* and *Cobra*. These were all very speedy vessels and the largest, the *Cobra*, was only 400 tons displacement. Hence, an idea rose that steam turbines for the propulsion of ships were most suitable for small, fast vessels, especially torpedo craft.

Now, there is no reason why turbines should be more suitable for small vessels than for large vessels; and for torpedo craft, turbines have the disadvantages that they have not as yet been got to drive a vessel economically at widely-varying speeds. Turbines would really seem to be most suitable for large highly-powered steamships intended to run always at their highest speed.

The advantage of having large diameters in steam turbines is not always understood. It is often supposed that the large diameter is preferred in order to give the steam a great leverage and so, it is argued, obtain a greater turning effect. The real reason is to allow of a less angular velocity; that is, fewer revolutions per minute being obtained. No matter what be the type of turbine, with a given number of stages or wheels or sets of moving vanes and a given boiler pressure and superheat, if any, and a given condenser vacuum, there is a certain vane speed which is best. Now, increase of diameter allows of a given vane speed being attained with a less angular velocity. Therefore, to keep angular velocities low, diameters are made great.

Angular velocities are often limited, notably, in the propulsion of ships. With marine steam turbines of the Parsons type efficiency and low cost are often sacrificed to a certain extent in order to get large diameters and to obtain low angular velocities to suit the screw propellers.

It has often been proposed to cause a steam jet to give up some of its velocity to accelerate another fluid and then utilize the mixture to drive a turbine. Exhaust steam, water and even mercury have been proposed as the diluting fluid. The idea is that by this device a lower velocity is obtained and that, therefore, a lower vane speed can be adopted without loss of efficiency.

This is true; but a little scientific consideration will show that the loss is likely to much exceed the gain. Take a simple case: Suppose that the steam jet has a velocity of 4,000 feet per second and that it mixes with an equal weight of diluting fluid which was previously at rest. The total momentum must remain constant and, therefore, as the moving mass is doubled, the velocity of the mixture must be half that of the original steam jet; that is, it will be 2,000 feet per second. Now two pounds of fluid with a velocity of 2,000 feet per second have only half the kinetic energy of one pound of fluid with a velocity of 4,000 feet per second, because the kinetic energy is proportional to the square of the velocity. The diluting scheme has, therefore, caused the loss of half the kinetic energy of the steam. If, instead of diluting the steam of the jet, the vanes of the turbine had just been run at half

the best speed, the loss caused thereby would not have exceeded 25 per cent of the initial kinetic energy of the steam.

It may be asked where the energy goes to that is lost in the diluting scheme. It produces heat of impact and eddies. These forms of energy may be utilized to a certain extent if the steam is expanded further after leaving the vanes just considered, but the useful work obtained from them will be only a small part of the kinetic energy wasted. Besides, if the jet had not been diluted but, instead, the vanes run at a speed less than that called for, the steam would have left the wheel with a considerable velocity which could have been turned into heat and utilized in part in the following expansion.

It is not surprising, therefore, that diluting for the purpose mentioned, although often proposed, has never got past the experimental stage. Diluting to reduce temperature is a totally different thing. This has been proposed in the case of turbines actuated by hot gaseous products of combustion and has much to be said in its favor.

GAS ENGINE ECONOMY.

From a Paper Read by C. E. Sargent upon the "Prime Mover of the Future," before the Western Society of Engineers, December 6, 1905.

There are three dispositions of the heat in the fuel which goes into a gas engine cylinder: Part of it, usually about 25 per cent, goes into work; about 40 per cent into the water jacket, and 35 per cent into the exhaust, radiation, etc. Now, if we can reduce the amount which is wasted, we of course increase the percentage turned into work. The amount going into the water jacket depends, other things being equal, on the amount of surface exposed during the inflammation of the

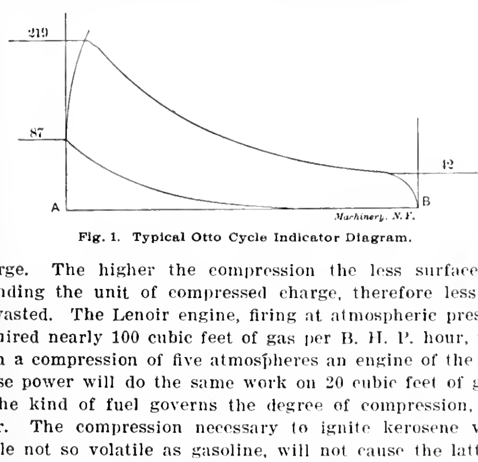


Fig. 1. Typical Otto Cycle Indicator Diagram.

charge. The higher the compression the less surface surrounding the unit of compressed charge, therefore less heat is wasted. The Lenoir engine, firing at atmospheric pressure, required nearly 100 cubic feet of gas per B. H. P. hour, while with a compression of five atmospheres an engine of the same horse power will do the same work on 20 cubic feet of gas.

The kind of fuel governs the degree of compression, however. The compression necessary to ignite kerosene vapor, while not so volatile as gasoline, will not cause the latter to burn. Natural gas can be compressed to 150 pounds absolute,

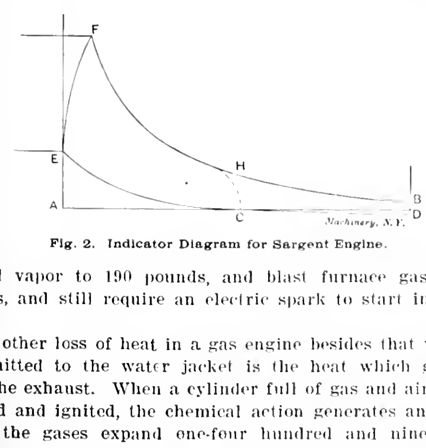


Fig. 2. Indicator Diagram for Sargent Engine.

alcohol vapor to 190 pounds, and blast furnace gas to 210 pounds, and still require an electric spark to start inflammation.

The other loss of heat in a gas engine besides that which is transmitted to the water jacket is the heat which goes out with the exhaust. When a cylinder full of gas and air is compressed and ignited, the chemical action generates an intense heat; the gases expand one-four hundred and ninetieth of their volume for every degree of Fahrenheit, and the chemical action even with a proper mixture is not instantaneous and often there is flame coming out with the exhaust.

If a full cylinder of combustible mixture is compressed from atmospheric pressure and temperature and heated further by chemical action, then when the volume is constant the pressure is increased and the release of this pressure when the exhaust valve opens causes the familiar "sea lion bark," always associated with the exhaust of a gas engine. This is the second loss of the internal combution engine, and when we consider that from 35 to 40 per cent of the heat is wasted in this way, is it any wonder that engineers have tried to minimize this loss? We all know the inefficiency of the direct acting steam pump and the gain by a more complete expansion, even though we get a lower mean effective pressure and consequently less power from the same cylinders. To utilize the heat and pressure in the exhaust, compound gas engines have been suggested, tried, and in some cases have shown an increased efficiency.

Fig. 3. Effect of Sargent Design with Variable Cut-off.

If steam were a perfect gas, void of cylinder condensation, an early cut-off in a single expansion cylinder would give as many expansions and as good economy as we get in the compound engine. The working fluid of an internal combustion engine is practically a perfect gas, therefore the efficiency of this type of prime mover may be increased if we can expand the working charge to a greater volume than is compressed.

To illustrate in a language familiar to the engineer: Fig. 1 is an indicator diagram from the ordinary Otto cycle gas engine of a popular make. In this diagram the compression is carried to 87 pounds above atmosphere, and after ignition and inflammation the pressure is released at 42 pounds above atmosphere, or 57 pounds absolute. Now, to increase the efficiency of this type of prime mover, a double-acting tandem engine was designed to give the diagram shown in Fig. 2 where *A B* represents the atmospheric line and length of stroke; with the average load the combustible mixture is drawn in at some predetermined point, *C*, where the admission is cut off and rarefied during the remainder of the stroke; the line *C D*, showing the pressure below the atmosphere. No work is lost in this rarefaction, and on the return stroke the compression above the atmosphere begins at *C*, reaching a predetermined pressure at *E*; *F E* is the firing line, and *F B* the expansion line, the release at *B* being slightly above atmospheric pressure. Instead of releasing at *H*, as in the ordinary gas engine, the expansion is nearly double the admission, and the area, *C H B C*, represents the increased work for the same quantity of fuel, and measures on the diagram from 22 to 25 per cent. No muffler is required and the temperature of exhaust is reduced about 1,200 deg. F. below that in the ordinary gas engine. The point of cut-off, *C*, is controlled by the governor moving toward *A* as the load gets lighter and the speed tends to increase, thereby reducing the quantity of the combustible mixture and necessarily the mean effective pressure. If the load gets heavier and the speed tends to decrease, the point *C* moves toward *B*, thereby taking in a larger quantity of the mixture, raising the mean effective pressure, and the pressure of release. If the point of cut-off, *C*, gives the highest efficiency at full load, then with an over-load or under-load, the efficiency will be decreased.

As in a steam engine, there is a limit to the degree of expansion desirable. When the pressure equals the power required to overcome the friction, a further expansion reduces the efficiency of the engine. For this reason an engine decreases in efficiency as the load gets lighter. In a single expansion steam engine it has been found that a terminal pressure of about four pounds above the atmosphere is the most efficient pressure of release while on account of the lower mechanical efficiency of the gas engine a terminal pressure of from 6 to 8 pounds seems to give the greatest economy.

In Fig. 3 is shown a diagram from this engine, with a variable load, in which the expansion line of the smallest

diagram approaches the line of highest compression, yet the highest and lowest compression lines show but little variation. The compression varies directly with an overload and must not get beyond the critical limit of self-ignition, yet the design of the engine is such that the compression only reduces one-half as fast as the cut-off, so that we maintain the highest maximum economy during the wide range of load.

Fig. 4. Effect of Variable Cut-off with the Typical Design.

If the time of ignition is such that with a full load the firing line is vertical, or what is better, leaning about 10 deg. from the vertical, as shown in Fig. 2, as the load gets lighter, the charge is reduced by either cutting off earlier, throttling or admitting less gas, depending on the type of engine, but as the products of combustion which fill the clearance space do not decrease, the mixture gets weaker, inflammation gets slower and the piston will often travel as fast as the rise in pressure.

Fig. 4 is a variable load diagram of an ordinary throttling engine with a fixed point of ignition from which we see that as the load gets lighter the initial pressure approaches compression. As the greatest heat corresponds to the greatest pressure, we note that the cylinder surface increases so rapidly, as the piston advances in the stroke, that the flame is cooled down as fast as it is propagated. This causes a loss of efficiency which is overcome in engines advancing the time of ignition with the cut off. In Fig. 3 the highest initial pressure remains where the cooling surface is least, maintaining a much higher efficiency than with a fixed ignition. The type of engine from which these diagrams were taken is shown in Fig. 5, where the charge is expanded to a terminal pressure which gives the greatest efficiency, varies the point of cut-off with the load, and advances the time of ignition as the inflammation gets slower. The frame is inclosed and self-oiling, without the crank or disks dipping into the oil. The side shaft is driven by a Rites governor and is advanced or retarded in time ahead of the crankshaft as the load varies, maintaining a regulation within 2 per cent between full and no load. Fig. 6 represents a section through the crank shaft of this engine and shows the worm gears which drive the side shaft. The driving gear is loose on the main shaft and is advanced or retarded relative to the shaft by the governor, depending on the load. The driven gear keyed to the side shaft opens or closes the valves earlier or later, maintaining thereby a uniform speed. As these gears should run in oil to be efficient, and as the engine bearings have to be copiously lubricated, the oil flows into the spaces between the teeth and is pumped through pipes to all moving parts.

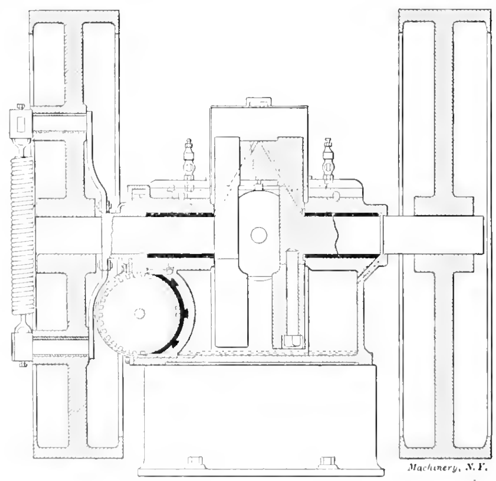


Fig 6. Cross-section of Sargent Engine.

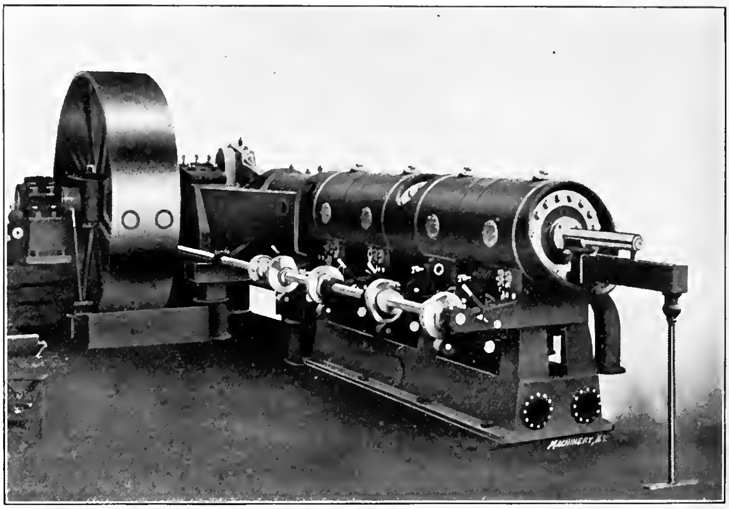


Fig. 5. Sargent Double-acting Gas Engine.

PIPE BENDS: THEIR APPLICATION, FLEXIBILITY AND COMPARATIVE COST.

Valve World, February, 1906.

A marked feature in the piping design of a modern steam plant is the free use of bent pipe. Until very recently bends were not utilized in this country to any great extent, although in European practice they were freely employed. No doubt the high prices of fittings in Great Britain and on the Continent forced engineers to turn to bends more than was necessary in America, but this necessity made for better pipe lines, as American engineers have recently realized, with the result that bent pipe is now utilized as freely here as abroad. Bends offer many advantages to the mechanical engineer in the way of making stronger lines, reducing friction, reducing the number of joints and compensating for expansion, and contrary to general belief do not add to the cost; in fact, in many cases the cost is reduced. Some of the more common forms of pipe bends and their application to steam lines are shown in the following cuts.

So far as can be ascertained, no thorough attempt has ever been made to determine the maximum amount of expansion which a U-loop, or quarter bend, would take up in a straight run of pipe having both ends anchored. Experiments in this direction would have to cover a wide range of sizes and materials, for flexibility increases with the radius and decreases with the diameter. It is also greater with full weight than extra strong pipe. The practical limit would also be governed by the strength of the material in the flanges or fittings to which the bends were bolted.

As far as the radii of pipe bends are concerned, local conditions in the average power plant prevent extremes in the way of very long bends. The Crane Co. have adopted five diameters of the pipe as a standard radius, which come nearer than any other to suiting average requirements, and at the same time produce a symmetrical article. Bends shorter than this can be made, but they are extremely stiff, tend to buckle in bending, and the metal in the outer wall is stretched beyond a desirable point. Very short bends must be made of extra strong pipe if a safe thickness of metal is to be maintained, and when it is necessary to use the minimum radius

to which extra strong pipe can be bent, such bends should be considered as fittings only, and not taken into account when making provision for expansion.

During the summer of 1905 the Crane Co. made a few experiments with 8-inch U and quarter bends to ascertain the amount of expansion they would take up. For the first test a run of 8-inch pipe, as shown in Fig. 14, was bolted together. The bend was made of steel pipe 0.32 inch thick, weighing 28 pounds per foot, with extra heavy cast-iron flanges screwed on and refaced. The elbows were extra heavy cast-iron, and the straight pipe was steel with extra heavy cast-iron flanges screwed on and refaced. The pipe was laid on rollers and anchored at points *AA* with indicators to detect any movement which might take place at points of anchorage.

Test No. 1.—After the line had been under steam about five minutes and the gages indicated 80 pounds pressure, one of the pipe flanges *B* broke on the north end, one length away no slippage at the anchors and the whole expansion of 3¾ inches was taken up by the bend. Outside temperature, 78 degrees.

Test No. 3.—Before removing the 8-inch U bend from the line a test was made to ascertain whether a bend of this kind would have a tendency to spread if the anchors were removed. The anchors were taken away and steam was turned in at 200 pounds pressure. The bend spread ¾ inch, which was about the natural expansion due to the temperature.

After removing the U-bend a quarter bend was put in at one end of the line, in the manner shown in Fig. 15. The line was rigidly anchored at points *AA*, and held at point *B* in such a manner that the pipe could not lift or move laterally. The bend was made of full weight steel pipe 0.32 thick, with extra heavy cast-iron flanges screwed on and refaced. The line flanges and fittings were also extra heavy cast-iron.

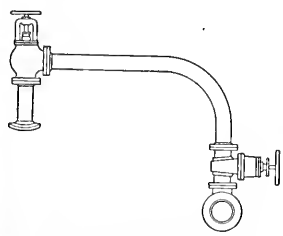


Fig. 1- Boiler and header connection

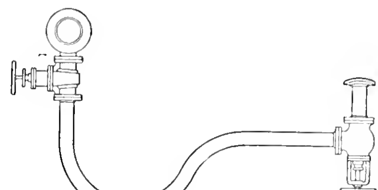


Fig. 2- Boiler and header connection when header is higher than in Fig. 1

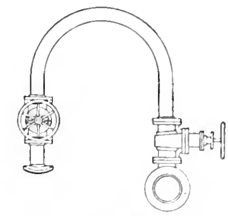


Fig. 3- Boiler and header connection with a U-bend

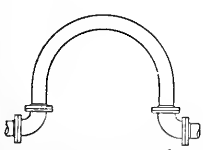


Fig. 4- U-bend located in a straight run to allow for expansion

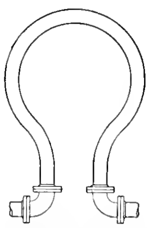


Fig. 5- Modification of Fig. 4- for limited center to center spaces

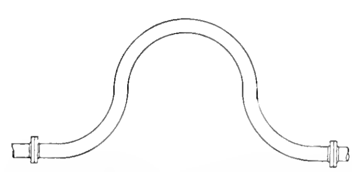


Fig. 6- Expansion loop in straight line. If made in a single piece, can be used only in 8-inch or smaller sizes.

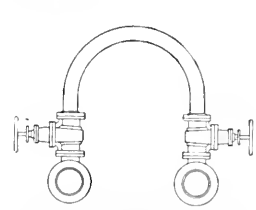


Fig. 7- U bend cross-connecting two parallel headers

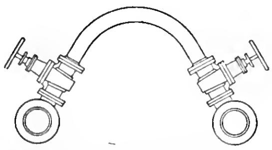


Fig. 8- Modification of Fig. 7- for special conditions. This form entails some loss in flexibility.

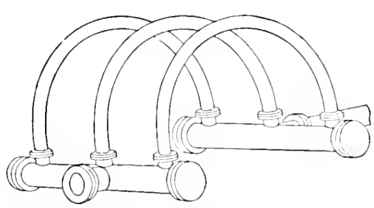


Fig. 9- Battery of three 8-inch U bends connected to headers and placed in 14 inch main steam line to take care of expansion and contraction. This combination is preferable to a U-bend the full size of the pipe, because of its greater flexibility.

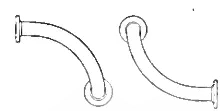


Fig. 10- Compound quarter bend to suit local conditions


Fig. 11- 45 bend

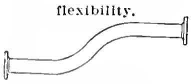


Fig. 12- Offset bend


Fig. 13- Crossover bend. Used when necessary to avoid other pipes, pillars, etc.

Machinery, N.Y.

Examples of Pipe Bends, with General and Special Applications.

from the elbow. The total expansion was 1⅞ inches at the time the break took place. The reason for the break was the lifting of the pipe, near the U bend, off the rollers, which would naturally throw a severe strain upon the line flanges. Outside temperature, 72 degrees.

Test No. 2.—This test was made on the same line. At 50 pounds pressure the line expanded on the short end ⅞ inch and on the long end 1⅛ inches; total, 2 inches. At 100 pounds pressure the expansion was 1 3-16 inches on the short end, 1½ inches on the long end; total, 2 11-16 inches. At 150 pounds pressure the short end expanded 1¼ inches and the long end 1¾ inches; total, 3 inches. At 200 pounds pressure the short end expanded 1½ inches and the long end 1⅞ inches; total, 3¾ inches. At 208 pounds pressure the line flange *B* again broke, due to the lifting of the line near the bend. As nearly as could be determined, the maximum amount of this lift at the elbows was 1¼ inches. There was

Test No. 4.—*Full Weight Quarter Bend.*—Steam was turned into the line and when the gage indicated 80 pounds and the line had expanded 1¾ inches, the joint at flange *C* commenced to leak, the lower part of the flange being forced back slightly on the pipe. This was a remarkable result, and it is difficult to account for the flange not breaking.

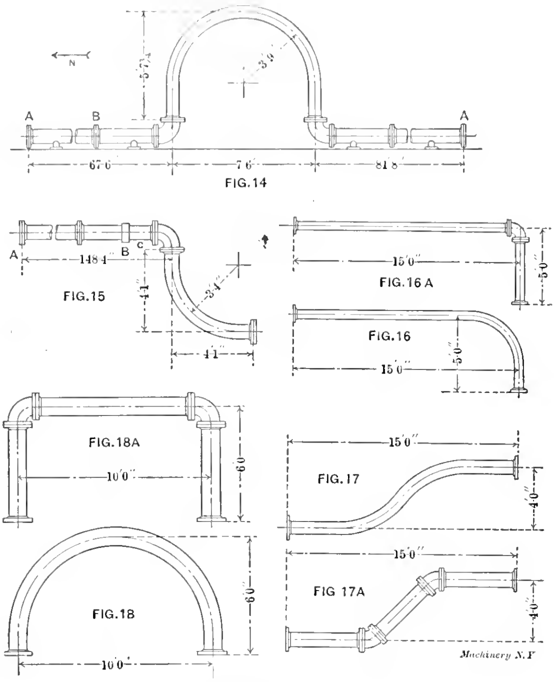
Test No. 5.—*Extra Heavy Quarter Bend.*—The full weight quarter bend was removed and an extra heavy bend of the same dimensions substituted, all other conditions remaining the same. Steam was turned on, and when the line had expanded ¾ inch, flange *C* broke at the top. A new flange was put on, and when the expansion was 1¼ inches the same flange broke at the bottom.

Further investigation along this line had to be abandoned for the time, as the space taken up was urgently needed. These few experiments were confined to bends having a radius of five diameters with short tangents. It is reasonable to

suppose that longer radii and tangents would make for greater flexibility.

As an illustration of the comparative cost of full-weight bends and straight pipe and fittings, take a 6-inch connection like that in Fig. 16. The value of a 6-inch full-weight quarter bend as shown, with extra heavy cast-iron flanges, and two sets of bolts and gaskets, is approximately $23.50, while the two pieces of pipe, elbow, flanges, and labor, as shown in Fig. 16A, with four sets of bolts and gaskets, would be about $26.

Or, take a 10-inch offset bend, made of full-weight pipe, with extra heavy flanges, as in Fig. 17. The cost of the



Arrangement for Testing Flexibility of U-bends, and Comparison of Bends and Fittings.

bend, with two sets of bolts and gaskets, is about $57. The pipe and extra heavy fittings, Fig. 17A, with six sets of bolts and gaskets, would be worth about $76.

An 8-inch U-bend with extra heavy flanges, as illustrated in Fig. 18, is worth about $41 with bolts and gaskets. Fig. 18A, with extra heavy fittings, bolts and gaskets, costs approximately $57.

A properly finished bend should bolt in place without strain. If it is necessary to force it into position there will always be a great strain upon the bolts and flanges, the joints will probably leak, and the benefits to be derived through the use of the bend will be partially destroyed.

* * *

MAKING STANDARD SCREW THREADS.—2.

The "Acme" thread is a modification of the square thread, designed to do away with some of the difficulties tending the construction of the older form. The principal objection to the square thread is the necessity for smoothing up the sides of the groove after it has been cut to the full depth. The sides are always left rough and are often scored by the digging in of the corner of the tool, since these surfaces are formed entirely by this corner and not by a shaving cut from a straight cutting edge. To overcome this difficulty it has become customary, while retaining the general dimensions of the square thread, to incline the sides of the tool at an angle of 29 degrees with each other, thus providing for a progressive shaving of the sides of the groove as the tool nears the bottom of the cut.

The working depth of the Acme thread is made the same as for the square thread. That is to say, the working depth

$$= \frac{1}{2 \times \text{the number of threads per inch.}}$$

To this amount, however, is added 0.010 inch at the bottom of the groove for clearance, thus making the total depth of the thread $= \dfrac{1}{2 \times \text{number of threads per inch}} + 0.010$. At what may be called the pitch line, at one-half the working depth of the thread, the width of the tool is the same as that of the square thread, being equal to the working depth. The inclination of the sides, however, gives different values to the width at the top of the thread and the width at the point of the tool. Of these the width at the point of the tool is narrower on account of the added clearance and is equal to $\dfrac{0.3707}{\text{number of threads per inch}} - 0.0052$. This formula holds true for a screw or tap thread. The width of a screw or nut thread at the top $= \dfrac{0.3707}{\text{number of threads per inch}}$. In cutting a tap the diameter must be made 0.020 inch greater than that of the screw to be used in the hole tapped, this allowance being made for the 0.010 inch clearance which the tap cuts on each side. This added diameter makes the width at the top of the thread equal to the width of the thread tool with which the tap is cut.

A table is also given for worm thread tools, and tools for British standard threads. It might be mentioned in connection with these tables, and those which appeared in the data sheet sent with the March issue, that dimension *A* gives the amount to be added to the readings given by a Brown & Sharpe thread micrometer to get the outside diameter. This refers, of course, only to the forms of thread for which the micrometer is adapted.

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THE ANTI-METRIC CHAMPIONS.

An informal dinner was given at the Waldorf-Astoria on March 31 by a committee representing manufacturers in many lines of business, to Frederick A. Halsey of the *American Machinist* and Samuel S. Dale, of the *Textile World Record* in recognition of their efforts in behalf of the established standards of measurement and in opposition to the introduction of the metric system in this country. A considerable sum of money was originally collected for presentation to Messrs. Halsey and Dale; but those gentlemen were much too modest to accept any compensation for their work, and suggested that the fund should be used to advance the cause by circulating and endowing their book "The Metric Fallacy." This plan was accordingly carried out and a copy sent to every member of Congress.

There were present at the testimonial dinner, besides the guests and committee (with the exception of Mr. Sharpe, who is abroad, and Mr. Durban, who was unable to attend on account of sickness) the editors and publishers of several trade papers identified with the interests affected by the contemplated change. The subject was very thoroughly gone over by various speakers, and plans for continuing the fight were considered. Messrs. Halsey and Dale were each presented with a cathedral chime hall clock from the funds collected by the committee, which consisted of Mr. Henry D. Sharpe, Brown & Sharpe Mfg. Co.; H. M. Covell, of the Lidgerwood Mfg. Co.; William Lodge, of Lodge & Shipley Machine Tool Co.; Thomas E. Durban, Erie City Iron Works, and Mr. J. H. Schwacke, William Sellers & Co., Inc., chairman.

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The students taking a mechanical course in Sibley College, Cornell University, are required to do a certain number of hours work each year. The time clock checking system is employed, each student being required to check in and check out, the same as if he were working in a regular manufacturing plant. The scheme not only gives an autographic record of the attendance of the student, but also introduces him to one of the features of real shop life which he will afterwards experience, if he enters the mechanical field where he should, that is, at the bottom.

JOHN E. SWEET.

REPRESENTATIVE AMERICAN MECHANICS.

John E. Sweet was born at Pompey, New York, in 1832. His boyhood was spent on his father's farm and was given up to the varied work that a farmer's boy is called upon to do and to securing a common school education at the local schools of his native town. His mother was an Avery—a name associated with some of the early and noteworthy mechanical work of the country. The Avery family numbered among its members many able mechanics, among them the Avery who patented the first American steam turbine, which was one of the earliest turbines in the world to be put to any practical use. In 1835 several of these were in operation, one being used to drive a saw-mill at Syracuse, N. Y. It is probable, therefore, that young Sweet was by inheritance destined to become a machinist and engineer; and this in spite of his early training, which was in quite a different sphere. That he had a mechanical bent was early evident, one of his achievements as a boy being the construction of a violin, which so pleased his parents that he had the distinction of being sent to take violin lessons—a very unusual event at that time for a farmer lad.

At the age of 18 he was apprenticed to learn the carpenter's and joiner's trade and his time was devoted to carpentry and building until nearly 30 years of age. After completing his apprenticeship he secured a position in the first architect's office opened in Syracuse conducted by Elijah T. Hayden, where he had an opportunity to become familiar with drawings of framed structures and building details. The laying out of such details passed for "architecture" in those days, since the artistic side of building design had not then received much attention, particularly in the smaller towns and cities.

The building plans of Sweet, the architect, bore the stamp of originality that has so characterized his later work. One of his most successful efforts, from a utilitarian point of view, was a set of plans for a model farm barn; and so great was the call for these that they were several times published in the *Rural New Yorker* and led to a series of articles in this publication by the young architect. This was the beginning of Prof. Sweet's work as an author and since those days manuscript from his pen has been eagerly sought by technical as well as popular journals and papers; for his writing has always been bright and original frequently suggesting new ideas and leading the reader along the paths of original thought.

His last work as an architect was in connection with the building of a hotel in Alabama, which was in process of construction at the outbreak of the Civil War. In common with many Northerners then in the South he came North with the opening of hostilities. Later he went abroad, traveling in England and on the Continent, the immediate reason for his trip being the famous London Exposition of 1862. While abroad he contributed a series of letters to a Syracuse paper, showing him to be a versatile writer along popular as well as technical lines.

Singularly enough the beginning of his mechanical career was made in England. He secured a patent on a nail machine in which the Patent Nut & Bolt Co., of Birmingham, England, took an interest so that he went there and entered their employ while superintending the making of his machines. While there he began writing upon technical subjects, contributing to London *Engineering*.

His mechanical career in America began in 1864 when he was employed by the firm of Sweet, Barnes & Co., of Syracuse as draftsman. He was here engaged upon a varied line of machines, one of which was a matrix-impressing machine arranged with a keyboard and aiming to do away with the use of movable type. This machine was really a progenitor of the present linotype machine and the first and only one constructed was exhibited at the Paris Exposition of 1867 and later presented to Cornell University, where it now is.

In the early seventies Mr. Sweet's efforts were extended in still another field—that of bridge building. At about this time, however, he had conceived the idea of his Straight Line engine which is inseparably connected with his name and is perhaps his most characteristic piece of work. The features of the engine are too well known to require extended description. Nearly every feature of the engine was different from what had been done before. The straight lines of the frame the oiling arrangement, the governor, the arrangement and location of the flywheel, the substitution of a plain sleeve for piston rod packing, etc., as well as other features, have been much discussed and have influenced machine design in general.

Prof. Sweet's connection with Cornell University began in 1873 and terminated in 1879. One of the first college machine shops in the country was established at this institution, and Prof. Sweet gave instructions both in shop work and in machine design. The second Straight Line engine built was made by students in this college shop and exhibited at the Centennial Exposition. The Sweet measuring machine was developed while he was at Cornell and was the first machine for accurate measuring made in this country. He introduced into the Sibley shop the making of scraped surface plates and straight edges, and of ground standard gages, at a time when such auxiliaries to shop processes were considered unnecessary refinements. Another of his Cornell products was the Sweet engine lathe, having a cone of change gears located in the head stock beneath the main cone of the lathe and so connected that any feed or thread could be obtained without putting on or taking off change gears as in the ordinary type of lathe. Another feature of this lathe was the support of the bed upon three points, a principle that he had adopted, also, in the Straight Line engine frame.

In an article contributed to the *Sibley Journal of Engineering* by Prof. Albert W. Smith, Director of Sibley College and a former student of Prof Sweet, are appreciative words concerning the latter's work. He says, "Prof. Sweet was an 'intuitive designer.' The rest of us struggle with mathematical intricacies toward uncertain results, while he sees the end at first and wonders that we do not. A mathematician once asked him about something that he had proved by pages of equations. Professor said: 'Suppose this and that, then the proposition is true, isn't it?' And it was true. But what are we going to do with our mathematics if things are to be done this way?

"In the 'old days' the shop—there was but one—was in the first floor room in the west end of Sibley. One could go there any day and find Professor Sweet whittling a pattern or scraping a surface-plate—for he always had work for his own hands—with a group of students standing around listening to a lecture that was not on the schedule. These lectures were among the best of our course. Or it would be an informal discussion. Some student had found an interesting unsolved question, and each student present would express his opinion and the fog would thicken till the question was entirely hidden. Then Professor would smile and shift the switch and turn clear light on the whole subject, and we would go away wondering how we had failed to see anything so simple.

"It would be natural that sound judgment should accompany Prof. Sweet's other straightforward qualities. Once an inventor of the tangle-brain type showed him an invention of great ingenuity and complexity. Then he asked him what he thought of it. 'Well,' said he, 'it seems to be a mighty good way to do a thing that doesn't need to be done.'

"Prof. Sweet's influence on his associates is strong because of his personal qualities. His keen sense of humor makes it a rare privilege to hear him tell a story or to tell him one. His kindness and ready sympathy make it a rare privilege to have him for a friend."

Shortly after his resignation from Sibley College, the Straight Line Engine Co. was organized at Syracuse, with Prof. Sweet as president and manager and the conduct of this business has been his work for the past twenty-five years. In the building and equipment of this plant his originality was manifest, as always. It was one of the first saw-tooth roof shops to be erected in this country and among the tools was a planer-type milling machine, then not a common machine in America, designed by him and built at the Straight Line Engine Co.'s works.

From time to time he has contributed to American technical publications, and it has not been uncommon for his articles to draw out a stirring discussion and quite likely with him taking, what has seemed to many to be the unpopular side. He has had no sympathy with the typical American idea of claiming everything for this country and seeing no good in the work of our friends across the water. While a true American himself, he has always been ready to acknowledge the worth of achievements of mechanics in other countries, and has openly expressed his approval of many of their mechanical designs and methods and has not hesitated to call attention to such features as he believed to be superior to the work of American mechanics.

Prof. Sweet was one of the founders of the American Society of Mechanical Engineers, was elected its third president and wrote the first paper presented before the society in recognition of his untiring services during its organization. He was also, later, elected an honorary member of the society. He is one of the members who is sure to become the center of a group of friends at the social meetings of the society when stories are told and experiences are related. A pleasant event was the presentation to the American Society of Mechanical Engineers of an oil painting of Prof. Sweet two years ago, which now hangs in the lecture room at the New York headquarters.

Prof. Sweet was one of the judges on machine tools at the Chicago Exposition; an expert for the government on gun lathes; and one of the founders and first president of the Engine Builders' Association of the United States. He has been president of the John Fritz Medal Association, one of the founders and first president of the Technology Club, and president of the Metal Trades Association of Syracuse.

One of the ambitions of Prof. Sweet has been the establishment of a trade school where young men can be instructed in the mechanical arts in a way to fit them to become mechanics This ambition, it appears, is likely to be realized, as about one-half of the required capital stock of $50,000 has been pledged by various manufacturers of that city. The prospectus issued by the committees reviews the conditions that manufacturers are feeling more and more, there being a lack of well-trained machinists and other skilled mechanics necessary in every shop. It states that the object of the school is to provide a shop in which young men may learn the art and acquire the handicraft necessary to meet the requirements of the modern shop. It is proposed to first organize a shop school fully equipped with machine tools with the necessary drafting, study and lecture rooms attached. The instructors will be men of practical experience like Prof. Sweet, who proposes to give half of his time to the school. It is planned to operate the shop school on a commercial basis, meaning by this that the shop will make articles that can be sold in the open market in competition with regular commercial shops.

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A common circumferential speed for a circular saw is 10,000 feet per minute.

TESTS FOR FAULTS IN ARMATURES.

NORMAN G. MEADE.

It is very desirable to be able to locate faults in motor or generator armatures around shops with simple apparatus that may be on hand. A method which has proven very reliable and requires only a few cells of battery and a telephone receiver is given below.

Test for Open Circuit. Clean the brushes and commutator, and apply current from a few cells of battery having a telephone receiver in circuit as shown in Fig. 1. If the machine has more than two brushes, connect the leads to two adjoining brushes and raise the balance. Now rotate the armature slowly by hand and there will be a distinct click in the receiver as each segment passes under the brushes until one brush bears on the segment at fault, when the clicking will cease. Note that the brushes must not cover more than a single segment.

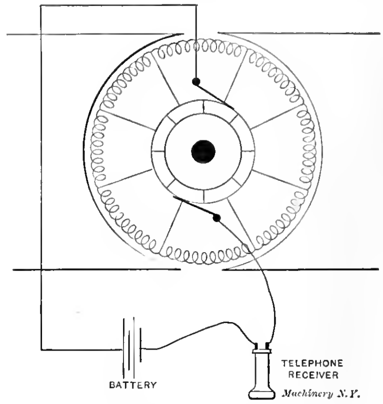

Fig. 1. Test for Break in Armature Lead.

If, on rotating the armature completely around, the receiver indicates no break in the leads, connect the battery leads directly to the brushes, as shown in Fig. 2, and touch the connections from the receiver to two adjacent bars, working from bar to bar. The clicking should be substantially the same between any two commutator bars; if the clicking suddenly rises in tone between two bars, it is indicative of a high resistance in the coil or a break (open circuit).

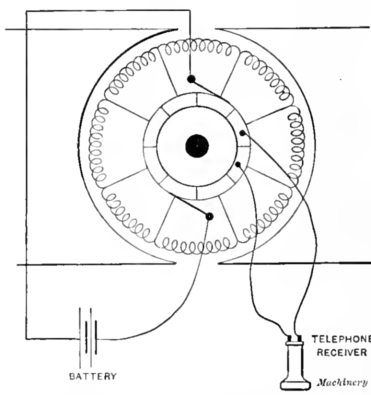

Fig. 2. Bar to Bar Test for Open Circuit in Coil or Short Circuit in one Coil or between Segments.

Test for Short Circuit. Where two adjacent commutator bars are in contact, or a coil between two segments becomes short-circuited, the bar to bar test just described will detect the fault by the telephone receiver remaining silent. If a short circuit is found the leads from the receiver should then include or straddle three commutator bars, as shown in Fig. 3. The normal click will then be twice that between two segments until the coils in fault are reached, when the clicking will be less. When this happens, test each coil for trouble and, if individually they are all right, the trouble is between the two.

Test for Grounded Armature. Place one terminal of the receiver on the shaft or frame of the machine, and the other on the commutator. If there is a click it indicates a ground.

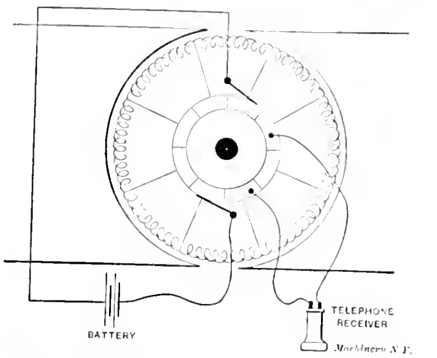

Fig. 3. Alternate Bar Test for Short Circuit between Sections

Move the terminal about the commutator until the least clicking is heard and at or near that point will be found the contact. Grounds in field coils can be located in the same manner.

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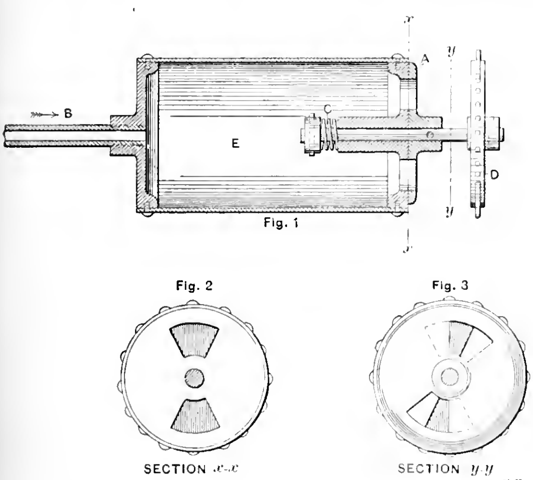
WEISS EXHAUST MUFFLER FOR GAS ENGINES

The sharp, gun-shot-like explosion of the gasoline engine is ordinarily muffled on the automobile by some combination of baffle plates which break up and retard the outflowing gases so that the explosive effect on the atmosphere is largely overcome. Unfortunately, these mufflers, in general, introduce considerable back-pressure and if they become clogged with carbon, as they are very likely to do, the back-pressure may become so high as to seriously retard the action of the engine



Exhaust Muffler for Gas Engines

and reduce its power. This is well recognized by automobilists, and in all road races the mufflers are removed so that the engines exhaust directly to the atmosphere. This is the reason for the sharp exhaust characteristic of the high-speed machines in such events.

The accompanying cut shows an exhaust muffler for gas engines which was designed to effectually prevent the noise of the exhaust without introducing much back-pressure. It is the invention of Louis T. Weiss, of Brooklyn, N. Y., and was applied by him to a Winton machine which had given considerable trouble because the regular muffler soon became clogged with carbon to such an extent that the power of the engine was greatly reduced. The construction of the device is simple, but its effect upon the exhaust is not apparent without some explanation. The exhaust from the cylinder is admitted through *B* to an expansion chamber *E*, Fig. 1, which at the time of the exhaust release, is closed. But, before the piston has traveled more than a small fraction of an inch on the upward stroke the rotary valve shown at *A* is opened, allowing the exhaust to escape freely to the atmosphere. The valve *A* is mounted on a shaft on which is a sprocket wheel, *D*. This latter is connected with a chain to the crankshaft of the engine and is timed so as to open as indicated in the foregoing. The explanation of the muffling action is simply that the explosive effect of the exhaust is reduced by its escape into the expansion chamber, which is about five times as large as the cylinder volume, and also because of the cooling effect. The chamber *E* acts in a measure as a condenser and by the time the rotary valve has opened the gases have cooled to such an appreciable extent that, with the reduction of pressure due to the greater volume, there is not the sudden sharp explosive effect that takes place when the exhaust valve is opened directly to the incandescent gases in the cylinder. To avoid danger of over-pressure in chamber *E* in case that the timing arrangement should fail, the sprocket shaft is provided with a collar at its inner end, and between this collar and the hub of the chamber head is a coiled spring; in case of over-pressure the rotary valve is lifted from its seat, by compressing the spring, which allows the gases to escape.

It is claimed that the reduction of back-pressure made possible with this muffler makes a surprising difference in the power of the average automobile engine and also permits the use of less battery power because the mixture will be uniformly richer. This, of course, results because of the freer exhaust and the consequent greater discharge of the exhaust gases from the cylinder. In case of considerable back-pressure the volume of exhaust gases left in the clearance space of the cylinder is sufficient to expand and considerably reduce the quantity of the incoming charge, thus making it so poor a mixture that a very strong spark may be required to fire it.

* * *

THOMAS RICHARD ALMOND.

Thomas R. Almond died at his home in Dunwoodie Heights, Yonkers, on March 31, 1906, following a six days' illness from pneumonia.

Mr. Almond was born in Uppingham, Rocklandshire, England, in 1846. He came of Norman stock, his ancestors having

Thomas R. Almond.

settled near his birthplace as far back as the Conquest. He early displayed remarkable inventive mechanical ability and at the age of twelve was awarded a special prize at a London exhibition for a model working steam engine involving an original and meritorious valve gear. He came to America in 1866, establishing himself as a machinist in Fitchburg, Mass., where he later married Eleanor Hortense Tollman, daughter of Cyrus Stone Tollman. The business was removed to Brooklyn in 1875, and has since grown to large proportions, developing engineering specialties under the Almond patents.

Mr. Almond was a versatile inventor, his numerous patents covering many fields. Those which have been commercially successful include the Almond chuck, the Almond portable

stove lamp, the Almond angular shaft coupling, the Almond turret head tool, and the Almond flexible metallic tubing. Two years ago, having relinquished control of his business, Mr. Almond then devoted his time to the development and perfection of a highly original and simple reaction steam engine which was nearly perfected at the time of his death. An unprecedented honor was his in being twice the recipient of the annual John Scott metal awarded by the Franklin Institute of Philadelphia for meritorious invention.

He was a member of the Canadian Club, the Scarsdale County Club, the Dunwoodie County Club, an enthusiastic officer of the Yonkers Choral Union, a member of the American Association for the Advancement of Science, and a life member of the American Society of Mechanical Engineers, in which he took an active interest and whose transactions have been enriched by his papers and discussions.

* * *

THE BURBANK QUICK CHANGE GEAR.

An interesting change gear mechanism has been invented, designed and patented by Louis S. Burbank, formerly of Worcester, Mass., and now of Phoenix, Md. This device has been carefully worked out, to the extent of redesigning seven or eight times, and two complete mechanisms, including the lathes to go with them, have been built by the F. E. Reed Co., Worcester, Mass., who have recently purchased a shop right for the use of the mechanism.

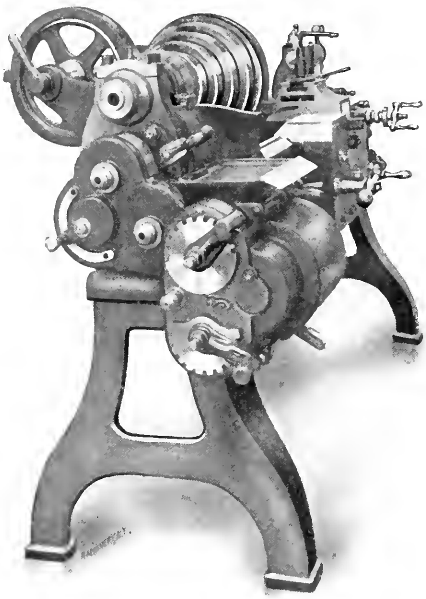


Fig 1. Reed Lathe Equipped with Burhank Change Gear Device.

In the Burbank device, the gear cone is held on a separate and "floating" shaft, with nothing else on the shaft but the cone of gears. Two gears which drive to and from the cone are constructed to slide back and forth on their respective quill shafts the full length of the cone; and are placed just far enough apart to allow them to pass each other. By this construction, either sliding gear will drive with any one of the cone gears independently of the other.

The term "floating cone" gives a first impression of instability; yet this method of securing this floating shaft is one of the features of the device. Each end is held in position by two links, which reach by straight lines from two quill shafts to the cone shaft, thus forming a triangle of links—the well known bridge construction principle. Within either quill shaft is a smaller rocking shaft, having a pinion near each end, one for each link, and having also a handle at the outer end to manipulate the links by. The pinions mesh into racks on the links, so that the manipulation of the upper and lower rocking shafts throws in or out the upper or lower pair of links, thus permitting any of the gears of the floating cone to be brought into mesh with either of the sliding gears. The photographs show a Reed lathe equipped with the device.

The details of the mechanism can be more fully explained by aid of the lettered and figured engravings, Figs. 2 and 3. In these 2 is the cone shaft supported by links A and B, and 1 and 3 are the quill shafts previously referred to. The mechanism is driven through the gear a fast to the quill on shaft 1 and motion is transmitted through the several gears as follows: From sliding gear b on the upper quill to the cone gear with which it is in mesh, as c; and from one of the cone gears, as d, to sliding gear e on the lower quill.

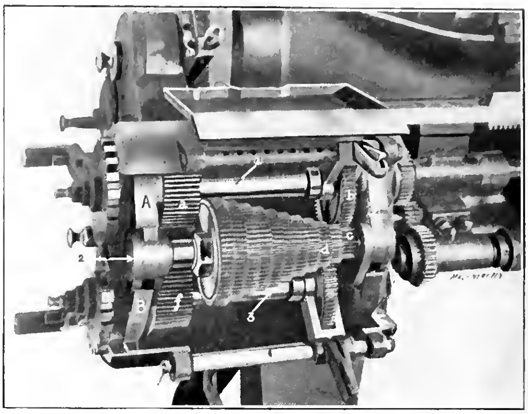


Fig. 2. Gear Case Cover Removed showing Arrangement of Geare.

Gear g on shaft 4 is driven by gear f on the lower quill and transmits motion to the lead screw or the feed rod as the case may be. The adjustment of links A and B is by means of the pinions on shafts 1 and 3 which mesh in racks cut in these links, as previously explained.

In connection with this speed box is an end combination of gears shown in Fig. 4 which has a two-gear cone and two sliding gears that are adjusted in much the same manner as the gears in the main part of the mechanism. The end combination, having two gears which are in the ratio of 2 to 1, gives three speeds, the extremes of which are in the ratio of 4 to 1. As the casing for the end combination is only two gears wide it is very compact in its arrangement.

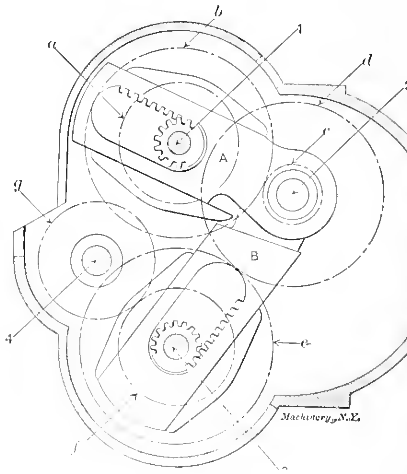


Fig 3. Diagram of Gearing.

The list for cutting threads is arranged in a unique way to facilitate the greatest convenience in setting. For instance, only the threads ordinarily used, namely, from 4 to 26, appear at all on the list, thus simplifying the use of the device, and it might here be added that all of these most ordinary threads are obtained *without* employing the end combination. As the end combination serves simply to multiply or divide these threads by two, the total range of threads is from one-half of 4 to twice 26; that is, from 2 to 52, and by a special position,

the finest threads are increased to 60, making 33 threads in all; but these are not all that can be cut on the device, as will be seen later.

The handles which operate the upper and lower sliding gears, above referred to, slide on rods which have notches in them to stop the handles opposite the several cone gears. The lower notch rod has for the normal threads, only two notches in it, for the sliding gear serves, in its right hand position, in a sense, as an end combination to multiply all the threads on the upper row of the thread list. But by rotating this lower

PARTIAL LIST OF SPECIAL THREADS

(The complete Table contains 174 different Threads.)

Columns 1 indicate Threads per inch expressed in Decimal Fractions.
Columns 2 indicate Threads per inch expressed in Common Fractions.

1	2	1	2	1	2	1	2
1.449	......	5.385	$5\frac{5}{13}$	9.857	$9\frac{6}{7}$	18.333	$18\frac{1}{3}$
1.538	$1\frac{7}{13}$	5.417	$5\frac{5}{12}$	10.145	....	18.461	$18\frac{6}{13}$
1.666	$1\frac{2}{3}$	5.455	$5\frac{5}{11}$	10.616	....	18.572	$18\frac{4}{7}$
1.812	......	5.555	$5\frac{5}{9}$	10.769	$10\frac{10}{13}$	18.841	......
1.818	$1\frac{9}{11}$	4.625	$5\frac{5}{8}$	10.833	$10\frac{5}{6}$	19.717	
1.923	$1\frac{12}{13}$	5.714	$5\frac{5}{7}$	10.909	$10\frac{10}{11}$	21.231	$21\frac{3}{13}$
2.083	$2\frac{1}{12}$	5.75	$5\frac{3}{4}$	11.111	$11\frac{1}{9}$	21.666	$21\frac{2}{3}$
2.174	..	5.797	......	11.25	$11\frac{1}{4}$	21.818	$21\frac{9}{11}$
2.222	$2\frac{2}{9}$	5.833	$5\frac{5}{6}$	11.428	$11\frac{3}{7}$	22.222	$22\frac{2}{9}$
2.273	$2\frac{3}{11}$	5.909	$5\frac{10}{11}$	11.5	$11\frac{1}{2}$	22.5	$22\frac{1}{2}$
2.308	$2\frac{4}{13}$	6.111	$6\frac{1}{9}$	11.6	......	22.857	$22\frac{6}{7}$
2.536	......	6.154	$6\frac{2}{13}$	11.666	$11\frac{2}{3}$	23.0	23
2.692	$2\frac{9}{13}$	6.25	$6\frac{1}{4}$	11.818	$11\frac{9}{11}$	23.333	$23\frac{1}{3}$
2.727	$2\frac{8}{11}$	6.272	$6\frac{3}{11}$	12.222	$12\frac{2}{9}$	26.637	$23\frac{7}{11}$
2.778	$2\frac{7}{9}$	6.364	$6\frac{4}{11}$	12.308	$12\frac{4}{13}$	24.444	$24\frac{4}{9}$
2.857	$2\frac{6}{7}$	6.428	$6\frac{3}{7}$	12.5	$12\frac{1}{2}$	25.0	25

notch rod, a large range of special threads, 174 in number, can be brought into instant use. Thus, in this special position of the lower notch rod, the number of threads obtainable is equal to those that could be cut if the gears of the cone were all loose, as in the old way, and used in all possible combinations.

These special threads are useful in many ways as in cutting worms, etc., and like a good many other new things, are not

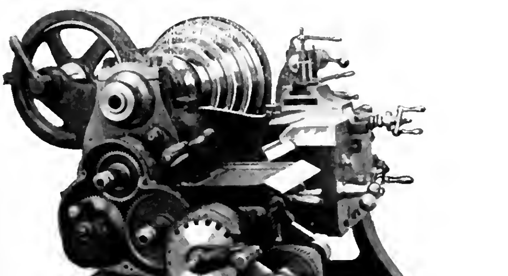


Fig. 4. Gear Case Covers Removed, showing Gears of Feed Box and End Combination.

fully appreciated until they are tried. For instance, suppose it was desirable to match a worm to a gear which was cut to an 8 diametral pitch; the threads per linear inch on the worm would be $8 \div 3.1416$, which equals 2.54, approximately. (In the table herewith are listed a few of the 174 special threads to be obtained. The first column gives the threads per inch expressed in decimal fractions and the second column the corresponding common fractions. As ordinarily arranged the table also indicates the positions of the handles for the different threads, but these are omitted in order to save room.) Looking on this table we find the pitch 2.536, which is close enough to the above 2.54 for all practical purposes. Or, again, 9 diametral pitch would require 2.86, and the table gives 2.857, very close indeed. Or, again, a 10 pitch would require 3.18, and the table gives 3.182, etc., so that in case a special thread is required one does not have to figure at all, but simply finds if the desired thread is on the list, and if so, set it on the lathe as quickly as any other thread. This flexibility is not had at the expense of simplicity, but is in the nature of the mechanism.

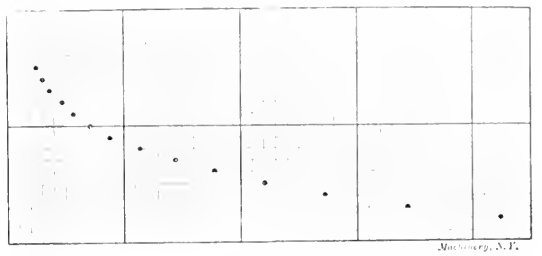


Fig 5 Diagram showing regularity of Speed Increments with Three-gear Device.

This device is also designed to give table feeds in a convenient way. Pushing in the knob at the left, throws the threads out of commission and the feeds in; then the same thread list on the lathe is used, and the range on the top row alone gives all the feeds ordinarily used. Any lighter or heavier cuts can of course be had by manipulating the lower handle and the end combination.

Another convenient feature of the device is that the actual cut per inch of work on the lathe can be known at any time by simply multiplying the indicated thread by 8; thus if the lathe is set to table feeds, and the position indicates 5 threads per inch, the cut is 5 times 8, or 40 per inch, etc. The speeds may be, therefore, designated by the numbers representing the various threads per inch, or they may be specified in the usual way and readily set on the lathe. For instance, work is specified to feed 30 cuts per inch; 30 divided by 8 equals 4 approximately. Therefore, set the handles at the position to cut 4 threads per inch, and run the carriage on the table feeds instead of threads. This eight is thus seen to be a very convenient figure to convert the threads to table feeds, and *vice versa*.

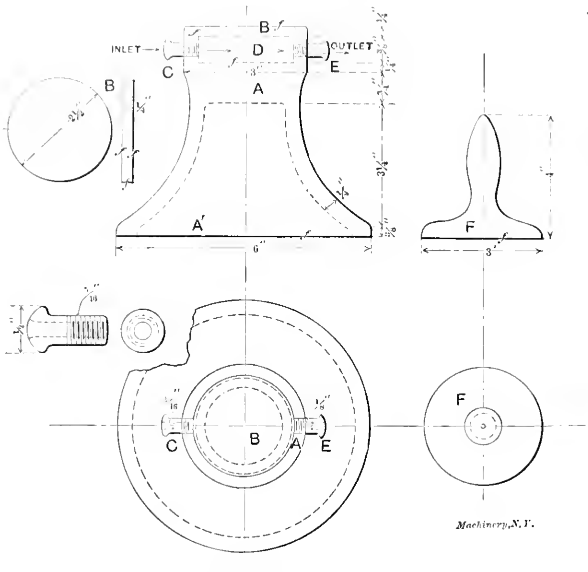
The latest design of this quick change gear makes it possible to cut both English and metric threads on the same lathe, including the English 19-pipe thread; and at the same time it greatly increases the range of special threads. But as this mechanism is not yet patented, it is not here made public.

The Burbank speed mechanism is not only suitable for thread cutting, but it is particularly well adapted for geared lathe heads, and perhaps this is its best field, because of its rigidity and flexibility of speeds, especially as these speeds can be arranged in geometrical progression. It is also adapted, however, for speed boxes for radial drills, etc. The number of gears in this mechanism is comparatively small. For instance, the number of gears on the cone for the geared head of a 16-inch lathe is only 3 for 14 speeds. This may seem incredible, but it is easily seen from the equation, $S = n(n - 1) + 1$, where S is the total number of speeds, and n the number of gears on the cone. In this case, S equals three times two plus one, or 7, and the back gear, or what is its equivalent in this mechanism, multiplies this 7 by 2, making the 14 speeds, above mentioned. The above figure shows a curve plotted from the design of a geared head for a 16-inch lathe, having only three gears on the cone. It will be noticed that no speeds are lost when the back gear is thrown in. In fact, it cannot be detected in the curve where this change is made. If such a curve were plotted from an old style belt-cone lathe, even of modern design, it would appear very erratic by the side of this almost perfect curve. For instance, as when throwing in the back gear, it is common to find the speed to be actually higher instead of lower than the slowest speed on the open belt, even with modern lathes of the best type.

LETTERS UPON PRACTICAL SUBJECTS.

TO HARDEN AND TEMPER THIN CIRCULAR SAWS WITHOUT WARPING.

After hardening the very thinnest saws possible to make, it is not the easiest thing to straighten them, but by employing the following method I have no trouble. I use no oil or other preparation in hardening the saws, but simply a cast iron pedestal, Fig. 1, through which flows a stream of water to keep it cold, and the hand block, Fig. 2.



Figs. 1 and 2. Hardening Pedestal and Hand Block.

A is the cast iron pedestal, having its base *A'* reduced by coring. The top of the pedestal is bored for chamber *D* and to receive the cast iron disk *B*, which is faced parallel and pressed tightly into place. Before *B* is pressed into place, however, holes for *C* and *E* are drilled and tapped into the casting *A*, these holes being made to receive brass nipples to which are attached rubber hose. Rubber hose is used inasmuch as it saves time in making the connection at the faucet and is most convenient to take down. *C*, being the inlet, is made larger than the outlet *E*, thus causing the chamber *D* to be constantly filled with water. The flow of water can be regulated at the faucet, and where there is no water faucet at the forge, a tank may be improvised by placing a pail of water above the pedestal, having a nipple connection on the side of the pail one inch above the bottom. A pail below the pedestal can serve as a drip tank. In this way a circulation of water through chamber *D* is assured and *B* is kept cold.

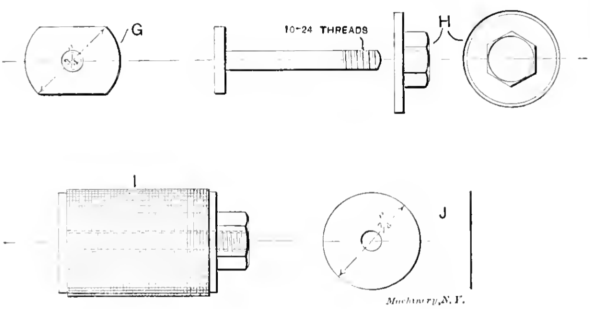


Fig. 3. Arbor for Stringing Saws when Temper is Drawn.

When sufficiently heated the saw is laid on *B* and the hand block *F* is instantly placed on top, thus cooling and pressing it flat. The hand block should not remain on the saw more than five seconds. While another saw is being heated the operator removes the hardened saw and any scale which may have accumulated. After all the saws are hardened, the hose and fittings are "shelved" until another lot is ready.

The next operation is the tempering of the saws. In drawing the temper I use a gang arbor $1\frac{1}{4}$ inch long which fits the hole in the saws closely. To prevent warping, they are strung on the arbor *G*, Fig. 3, as many being put on as possible, making allowance for a polished washer and nut, *H*. The saws are then clamped together by screwing up the nut as tight as possible.

The saws should be drawn slowly, and should be kept revolving, now and then being dipped in water. This process is continued until the desired temper is shown by the polished washer, which should be repolished after each operation.

The thinnest saws are 0.0035 inch thick, $\frac{7}{8}$ inch diameter, and have 125 teeth. The saws give perfect satisfaction on automatic machines doing the finest class of work in the world. To harden saws 1/64 inch thick, or thicker, I would suggest using oil, putting on just enough to keep the top of the pedestal well oiled. The manner of ganging the saws is shown at *I* in Fig. 3.

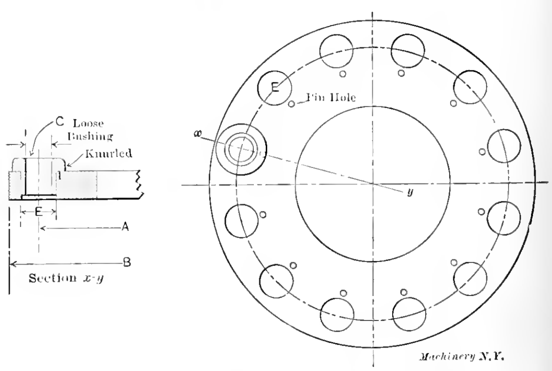
S. C. Smith.

TEMPLATE FOR DRILLING FLANGES AND FLANGED FITTINGS.

Calvin B. Ross.

The template shown in the cut is a very useful article for the purpose for which it is intended, namely, that of drilling flanges and flanged fittings. In cases where parts are to be interchangeable or to be duplicated at different times, the only accurate method of drilling such fitting is, of course, by means of a jig or template which prevents any error arising when such parts are duplicated.

The cut below illustrates a template which combines simplicity, cheapness and beauty (as it were). The ring proper may be made from a companion flange, the size for which the template is to be used, by cutting off the head and finishing all over, thickness being approximately 1 inch. *B* is made equal to the outside diameter of the flange and *A* is the diameter of the bolt circle. A removable bushing, such as shown in section *x y*, is used and moved from hole to hole



Template for Drilling Flanges and Flanged Fittings.

as required. The advantage of this loose bushing over a stationary one in each hole is obvious, lessening the cost of the template more than one-half. The bushing is made from machinery steel, knurled where indicated, and hardened. The small pin prevents the bushing revolving, due to motion of the drill.

Calvin B. Ross was born in Urbana, O., 1882. After completing a high-school course he studied at the Urbana University and later at the Ohio State University, from which he graduated, receiving the degrees of M.E. and E.E. He now holds the position of engineer and draftsman with the Hoppes Manufacturing Co., Springfield, O.

I have in mind a case where a standard pressure and low-pressure drilling job calls for the same number of bolts in the same bolt circle, but different sizes of bolts. In this instance all that is necessary is to have two bushings, with the same diameter, E, while C is made to correspond with the diameter of holes required.

This is surely a neat design of a well-known scheme, and is one which will be appreciated by men having such work in charge.

CALVIN B. ROSS.

Springfield, Ohio.

A SHOP FREAK.

A somewhat interesting incident occurred, which from the standpoint of the curious, might be worth noting.

An operator was drilling a hole in a cast-iron upright. A chaplet had been cast in, near where the hole was to be drilled. The workman had a freakish notion that he could not drill any but the smallest size holes without first drilling with a smaller size drill. In this case he drilled a ¼-inch hole first. This hole barely cleared the chaplet and when the larger sized drill was used, it, of course, came in contact with the chaplet. The workman had thrown in the feed and was running at a high speed. As the drill came in contact with the chaplet its cutting was effectually stopped. The

Fig. 1. Twist Drill that Encountered a Chilled Chaplet.

metal of the drill was obliged to find an opening somewhere as it was being fed in steadily at the top of the hole, so a portion continued downward into the ¼-inch hole; the remainder, by this time red hot and semi-plastic, was forced back up the flutes of the drill itself, notifying the workman upon its arrival at the top of the hole that something had gone amiss at the other end. Before the operator discovered it fully ¾ inch of the end of the drill had been forced through this process. A vise, a drift and hammer and considerable expenditure of elbow lubricant were necessary to release the drill from its socket, after removing it from the hole.

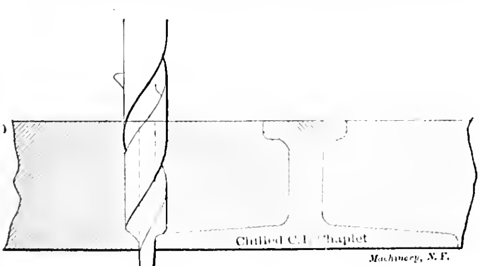


Fig. 2. Showing how the Freak Developed.

The sketch Fig. 2 will serve to illustrate what took place when the drill came into contact with the chaplet. This drill, while not of the high-speed quality of steel, had been used in all sorts of work previously and had never shown distress before. The ¼-inch drill, which, through the workman's notion, was first used, had just escaped the edge of the chaplet, which was made of hard chilled iron, and was used originally in holding the core in place when the piece was cast.

J. H. V.

TO LEVEL UP A LATHE.

When a new lathe comes in the shop the first thing to do is level it up and get it ready for business. The usual way to level up a lathe bed, or any machine of similar construction, is to true it up by the ways with a spirit level. In many cases, this might prove to be near enough; providing, however, the level being used was correct. There may be other and better ways, but the writer knows of none more simple or satisfactory than the following:

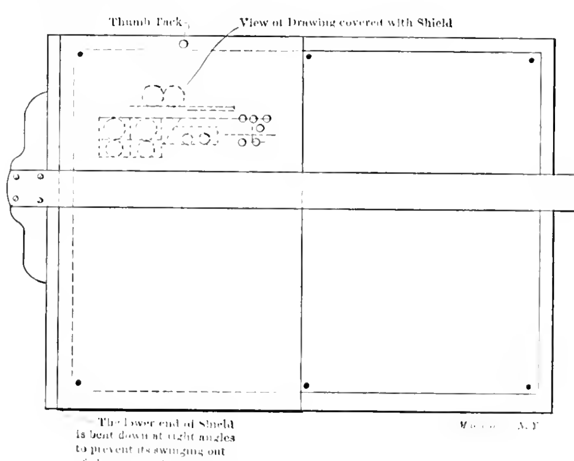
Procure a stick or narrow piece of board about six feet long, two or three inches wide, and an inch thick, and fasten it securely to the side of the carriage with a bolt or clamp and perpendicular to it. At the top, drive in a pin or nail, whichever is the nearest at hand, and from this pin suspend a common plumb-bob, letting it fall to some given point on the carriage, the point being as near the given point on the carriage as possible without touching it. A sheet of paper with a pencil-mark is all right as long as it is kept stationary. Move the carriage as close to the headstock as possible when setting the point. Now run the carriage down toward the footstock to the extreme end of the bed, and if it is not exactly level the plumb-bob will be seen to move away from the dot on the paper in the direction which the bed is out. By carefully shimming up the legs it can be made level at any point, thus eliminating the "wind" so commonly found in such machines when proper care has not been taken in setting them up. This may be an old idea to some of your readers, but it has been found to be a good one.

H. H. G.

A CELLULOID PROTECTOR FOR DRAWINGS.

Robert A. Lachmann.

It is a well-known fact that in laying out and designing any mechanism of a complex nature several erasures occur which roughen the surface of the paper and make the dirt-catching "stunt" a very easy one. Assuming that the upper right or left corner of a sheet has a side view which has been worked on for several days and is in pretty bad shape (which is generally the case, especially where the drafting room has any connection with the machine shop proper) and it is now required to draw a front view of the same object, it is, of course, necessary to transfer the center lines, make comparisons, take off measurements, etc., from the side view, and for this reason it is certainly proper to have the side view constantly in sight.



Celluloid Protector for Drawings.

To cover the part already finished with a piece of paper is all right in its way and is better than nothing, but imagine the annoyance of always having to lift the paper covering in order to see the sketch. I overcome this trouble in a very simple manner; the covering consists of a sheet of celluloid (the

ROBERT A. LACHMANN, was born in 1875, at La Salle, Ill. He served an apprenticeship with the Challenge Machine Co (formerly Schniedewend & Lee), Chicago, and has worked as a journeyman for the Sprague Electric Elevator Co., the Singer Sewing Machine Co., Rudolphi & Krummel (now the American Can Co.), and others. He was at one time superintendent of the Morgan Machine Co., and was in charge of the tool-making department of the Chicago Street Railway Co. His specialty is tool and die making.

thinnest transparent, about 0.010 inch thick) which will cover one-half of the drawing. The price of such a sheet, in this case about 12 x 18 inches, is only 50 cents, and it will save its cost over and over again. It is self-evident that by using this sort of shield the T-square in sliding across the sketch covered cannot injure it and furthermore, if the celluloid is bent at its lower edge as indicated in sketch and a single thumb tack used at the upper end it is an easy matter to shift the shield from left to right or *vice versa*. If it should be necessary to get at both views occasionally it is not even necessary to remove the tack; simply lift the T-square and swing the celluloid shield so it hangs down from the back of the drawing board.

It is a pleasure to work on a drawing with a shield of this description as the lines can be seen practically as well through the shield as if it were not there; likewise measurements can be very readily taken off. ROBERT A. LACHMANN.

Chicago, Ill.

FINDING THE COST OF LATHE WORK.

The concern of which I write probably has one of the best equipped plants in the country, and this letter is on the turning out of a few pieces, which they make day after day at a

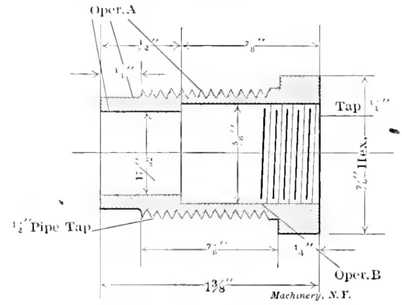


Fig. 1. Nipple made from Hexagon Stock.

record-breaking speed, and their method for ascertaining the cost of the articles manufactured is as follows:

We will take for instance the small piece shown in the sketch, Fig. 1; this is made from the hexagon bar in two operations, *A* and *B*. Operation *A* is turned out at the rate of 475 per day of 10 hours or 47½ per hour; and *B* at the rate of 200 per day or 20 per hour. We take neither the minimum nor maximum turned out, but the average and in this way the time in setting up and turning of the turret is considered in with amount turned out. Neither do we make any allowance for grinding of the tools for there are duplicate sets which the toolroom keeps in working order.

Now operation *A* is done on an Acme automatic by a 20-cent man who runs three other machines, and if he gets 20 cents per hour it makes the running cost of this particular machine 20 ÷ 4 = 5 cents per hour; if we turn out 47½ per hour, one will cost 5 ÷ 47½ = 0.1 cent. Operation *B* is done on a hand screw machine run by a 20-cent man, and he turns out 20 per hour. So 20 ÷ 20 = 1 cent for *B*; 1 + 0.1 = 1.1 cent, total cost of the operations on Fig. 1, which plus the cost of raw material equals the nominal manufacturing cost.

Fig. 2 shows a piston, which is done on five different machines in seven operations. When the operations require more than one minute they can be figured as follows:

Operations *A* and *B* are both done on the same machine, a Potter & Johnson automatic run by a 20-cent man who runs three machines. Operation *A* takes 9 minutes and *B* takes 24 minutes. 9 + 24 = 33 minutes, which divided by 3, the number of machines run by one man, equals 11 minutes for operations *A* and *B*.

The rate of the man's pay (20 cents) divided by 60 equals the rate per minute, or .33 cent. If the rate is .33 cent per minute, and it take 11 minutes, .33 × 11 = 3.63 cents, cost of two operations. Other operations are worked out the same way. Below is a form giving in detail the information needed on this piston:

Operation.	Machine.	Rate. per hour. cents.	Rate. per min. cents	Time, min.	Cost, cents.
A and *B*	Potter & Johnson Automatic	20	.33	11	3.63
C and *D*	Radial Drill	20	.33	5½	1.81
E	Small Drill	15	.25	4	1.00
F	Grinding Mach.	18	.30	11¼	3.37
G	Lathe	25	.41	13½	5.53
				Total,	15.34

15.34 cents, cost of piston operations plus the cost of casting, equals the nominal manufacturing cost of piston, that is, without the cost for supervision or shop burden.

Cleveland, Ohio. CARL D. SALISBURY.

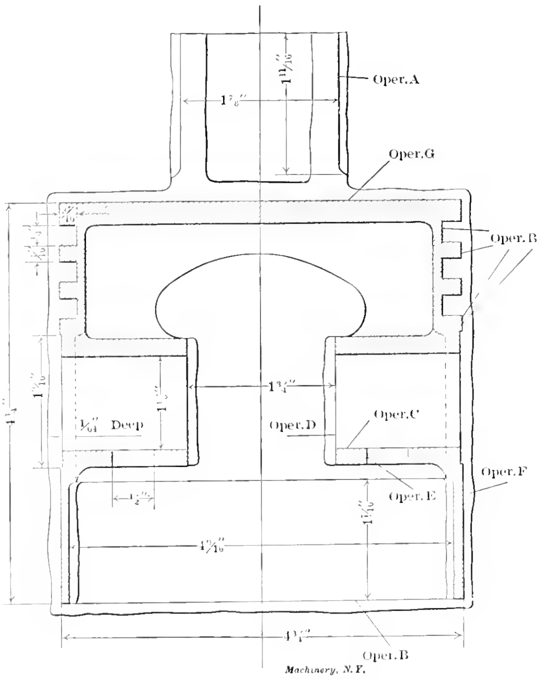
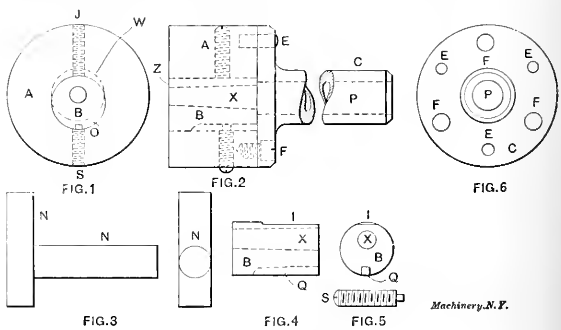


Fig. 2. Gas Engine Piston selected to Illustrate the Finding of the Cost of Lathe Work.

NOVEL HOLLOW MILL.

The accompanying sketches show a hollow mill designed to be used in a hand screw machine for machining the forgings, Fig. 3, on the surfaces *N N*. Two of these mills were made, one rougher and one finisher. They were constructed with the view of saving labor in replacing wornout tools. The con-



Novel Hollow Mill.

struction consisted of an outside mill *A*, bored eccentric to receive the inside mill *B*. *B* is held in position with set-screw *J* and screw *S*, which latter has its inner end turned to fit the spline *O*. These mills *A* and *B* are fastened to the shank *C* (which fits the turret head) by screws *F* and the dowel pins *E*. Figs. 4 and 5 show the inside mill *B*. Flats are milled on top of *B* at *I* for the screw *J* to seat against, and the spline is milled on bottom as above stated. The hole *X* is slightly tapered back from the cutting edge *Z* for clearance, and hole *P* in shank *C* is drilled for chip room.

It is obvious that if this mill were made solid, its life would be short, as the teeth get severe usage at the center, especially in the roughing tool, which has to cut against the rough scale of the forging. We found on trial that the outside cutter *A* would outwear seven inside cutters *B*. Outside dotted lines *W* represent the true sweep of the work against the mill; *A* and *B* being eccentric prevent any fin forming on the work where the mills match, otherwise if the mills were made concentric this trouble would result.

E. W. Norton.

COMMENT ON "MILLING CUTTERS."

I wish to call attention to a mistake in Fig. 7, in the article "Milling Cutters," appearing in the April issue of Machinery. This drawing shows the cutter being cut with negative rake, which, I presume, was not the intention of the author. I would let this pass as a slip of the pen, were it not that I have seen this same mistake in practice a number of times. The cutting line should have been behind the center line instead of ahead of it.

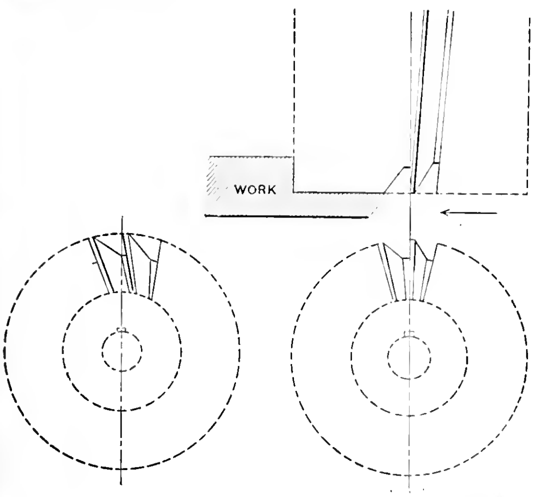


Fig. 1. Fig. 2.

In this connection, I wish to remark here that the use of rake in milling cutters is not nearly so common as it should be. It is true that not every cutter can be used with rake, but it is equally true that only a small portion of the cutters which might have rake are ground that way. There are two main reasons why the rake for a milling cutter may not be advisable: one is, that a cutter ground with rake is liable to produce a rather poor surface; the other is, that the spaces between the teeth are liable to be filled up with chips. It is generally easy to avoid trouble on the latter score by providing means for washing the chips away or blowing them out. As far as the first reason is concerned, this is not quite so bad as it looks. In the first place, where one operation is done, on a great number of parts, it would be easy to have two cutters, one for roughing and one for finishing. This is something which, for some reason, is too much neglected in milling practice. I presume there is a bit of ancient history behind this practice. It is not so long ago that most shops had only one or two milling machines, which were mainly used for tool work, or such operations as could not possibly be done on any other machine. As a consequence, there was a very great number of costly milling cutters for only one or two machines. It was quite natural then, that this large number of cutters was not doubled again so as to get one cutter for roughing and one for finishing. As a rough surface was positively inadmissible, it followed that the cutter had to be made in such a way that a good surface was produced. That the cutter was not a decided success as a roughing cutter was regretted (if it was noticed at all), but this defect was considered as hot weather in summer—not nice, but what are you going to do about it? Now that the milling machine is beginning to be recognized as a factor in the rapid production of work in manufacturing shops, it seems that the time is past when people could be satisfied with a slow cut, because the same cutter which takes a fast cut will not make a good surface.

It is further remarkable that in almost all cases that have come to my notice the rake of the teeth of face or end cutters is given in the wrong plane; that is, the teeth are ground with an angle in a plane where this angle does no good at all. The impression seems to prevail, that the radial teeth of the end cutter do the cutting, whereas, as a matter of fact, this is done by the cylindrical part of the cutter.

Fig. 2 shows a cutter at work as an end cutter. If this cutter were feeding in the direction of its axis, then it would be proper to give it rake, as shown in Fig. 2. However, as it feeds in the direction of the arrow, at right angles to its axis, the rake should be given as shown in Fig. 1. It is very seldom, though, that I have seen this done. This matter of giving rake the wrong way becomes a very serious matter

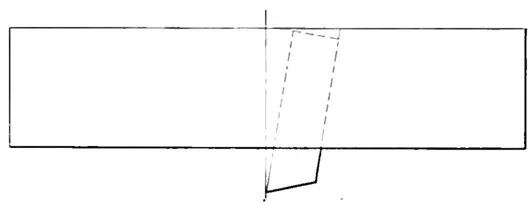


Fig. 3. Common Inserted Cutter Construction.

with milling cutters of large size with inserted teeth, such as are used for rotary planers. It may seem almost incredible that such serious mistakes are made with a tool so well known, but I have seen it time and again.

Fig 3 shows a cutter with inserted teeth of common construction. The slots for the cutters are milled at an angle, so as to produce the necessary rake without grinding. This is quite common practice. As a matter of fact, however, this

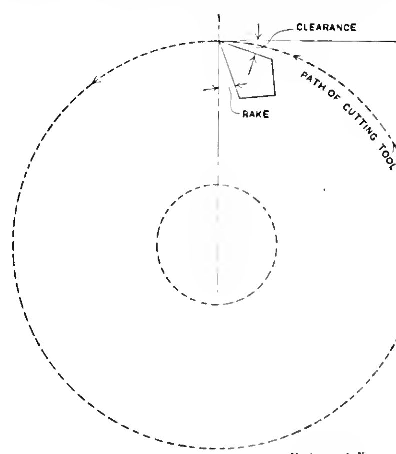


Fig 4. Showing how the Angles should be Ground

angle of the slots does not produce any rake whatever. Fig. 4 shows one of the cutting tools of the milling cutter and its path. It is easy to see from this figure how the angles should be ground.

Much more could be said on this subject, but this will do for the present.

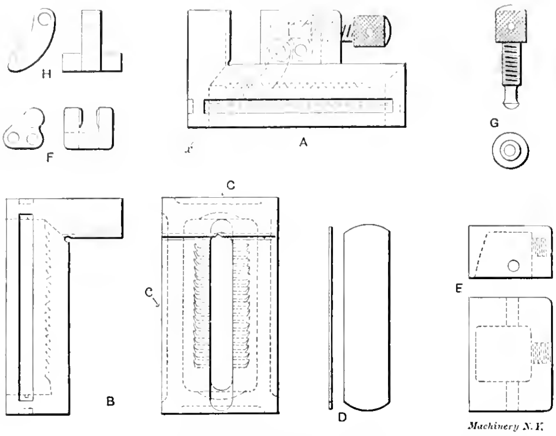
A. L. DeLeeuw.

Hamilton, Ohio.

TOOLMAKER'S VISE.

In the shop where I was employed some months ago there were about 75 toolmakers and every one seemed to have better ideas than the other, paradoxical as it may seem. This simply means that they had different views. One day one of them showed the other a design of toolmaker's vise. It was well demonstrated and every one seemed to like it very much, but when he made it they one and all had something to say against it. The principal objection seemed to be that the hook screw extended above the top of the rear jaw so that when using it for grinding or planing lengthwise the nut was in the way. Another vise was immediately made by another toolmaker, us-

ing the same design but with the hook screw shortened and the nut countersunk into the rear jaw at an angle of about 45 degrees. With this a cup-wrench was required to tighten the nut. At the same time still another vise was made of an entirely different design of tightener in the rear jaw which when compared with the other proved to hold the work much more tightly when screwed up with about the same power. It is a common saying that it takes a good man to design a creditable job, but any fool can criticise, and I must confess that I am one who is guilty in that respect.



Toolmaker's Vise, and Parts.

But having found this tool very simple and convenient in its construction, I thought it worth while to illustrate it in MACHINERY, for we all know how difficult it is at times to handle small pieces of work; it is often necessary to solder them onto a plate in order to do accurate work. The vise is made square and parallel on all sides and is 2 13-16 inches long, $1\frac{1}{2}$ inch wide and $1\frac{1}{2}$ inch high. The sketch at *A* shows the vise assembled, and surrounding it are the parts. *B* is the body made of tool steel and pack-hardened, ground and lapped square all over; it is milled out inside and 19 ratchet teeth are cut with an end mill at an angle of 30 degrees. In the center is a slot with round ends in which the hook *H* can move freely. A V-groove of 45 degrees angle is cut in the face of the stationary jaw square with the base so as to hold small round pieces vertical. On each end inside is cut a narrow slot 1-16 inch deep to fit the thin spring plate *D*, which is inserted to prevent the hook dropping down. The movable jaw *E* is also made of tool steel and pack-hardened, ground and lapped all over. A recess is cut in the under side of the sliding jaw with a round cornered end-mill, and a pin-hole is drilled transversely through the jaw for the pin to hold lever *F*; at the back a 5-16 inch hole is drilled and tapped for screw *G*. The hook *H* is made of tool steel hardened in oil and drawn to a straw color. It is made T-shaped, the body being slightly less than $\frac{1}{4}$ inch thick so as to work freely in the slot in the base, and a pin-hole is drilled at the upper end through which a pin is fitted to join it to the lever *F*. Lever *F* is made of tool steel pack-hardened while screw *G* is spring tempered; the screw is made 20 pitch left-hand so that when turned to the right it will tighten the jaw. The line $x—x$ through the point of the hook and the centers of the lever *F* when in line should make an angle of about 45 degrees so that when the screw is tightened the jaw will be drawn down against the base with about the same resultant pressure as is applied against the stationary jaw. O. WESTBERG.

MOUNTING BLUEPRINTS.

We have heard it said: "Of making many books there is no end," and it is equally true that of making many blueprints there is no end. It is, of course, very evident that the life of a blueprint is limited, but a blueprint which is properly mounted will outlast several that are unmounted. Many think it is a serious matter to mount prints satisfactorily, and so they don't try. It is really a very simple matter, however, and the results will amply justify the effort. Sheet iron, about 18 or 20 gage, either black or galvanized, makes a very satisfactory mount, but must be coated with shellac before using to prevent chemical action destroying the print. Mill board about ⅛ inch thick makes a lighter mount, but not so durable. When using the mill board, a piece of paper the same size of the print must be pasted on the back to prevent curling, and the face of the mount should be brushed over with paste. To do the mounting you will require a brush and a small rubber roller, which can be purchased for fifteen cents from a dealer in photographic supplies. To make the paste, dissolve a heaping tablespoonful of corn starch in a pint of cold water. Heat while stirring until it just begins to boil. Lay a print face down on a table or bench, brush the back evenly with paste, pick the print up by two adjacent corners, holding with pasted side away from you. Standing in front of the mount which is lying on the table, a quick forward motion of the hands will cause the blueprint to assume a nearly horizontal position, owing to the resistance of the air, and it can be quickly lowered into place on the mount. Now, with the roller, beginning at the center and working toward the outside, the print can be pressed into contact at all points. If the paper wrinkles, lift the corner nearest and get busy with the roller, working from the center always. You will be surprised to find how easily you can handle a 24 x 36 print by two corners after the first few trials. After mounting, the prints may be varnished or given a coat of shellac if desired. A hole should be provided at the top and a place provided for each workman to hang prints when practicable. W. W. W.

WEAK STEAM FITTING.

The accompanying photographs illustrate very clearly what it is well to avoid in the way of steam fittings.

I had occasion a short time ago, to use a half-inch plug cock for a day, and so went to a hardware store and took one out

Fig. 1. Showing Collapse of Plug Cut.

of stock, on the assumption that anything would probably last for that length of time. It was put in a steam pipe subjected to 165 pounds pressure, and leaked the first time it was

Fig. 2. Showing Softness of the Metal.

shut off. This leak grew worse and in a half-day the plug was removed in the condition shown in the illustrations. It worked all right so long as it was open, but when it was closed the steam pressure caused one side of the slot to col-

lapse and forced the other against it and into the passage in the case, to such an extent that the outline of the latter appears clearly cut in the body of the plug.

The cock was simply too light, and the excuse would probably be made by the maker that it was not designed for such a high pressure. To which the reply courteous would be: "If it collapses so completely under a pressure of 165 pounds, what is the real factor of safety at its proper working pressure of certainly not less than 100 pounds?"

The fact is, the maker is looking for trade, and the buyer is looking for a bargain, so the former cut down his weights until he produced an article that could undersell others and which was as worthless as it was attractive in price. It is merely another case of the bargain counter spirit run riot, an instance of the expensiveness of low-priced goods, and a good warning that the solid and substantial are the cheapest goods in the end, especially in the matter of steam and water fittings, where the cost of labor for replacement is usually much more than that of the goods. GULF.

THE KNIFE-EDGE STRAIGHTEDGE.

Mr. F. N. Gardner, in the November, 1905, issue of MACHINERY, has made some statements on lapping straightedges that are so contrary to my practice that I am tempted to take up the subject with him.

His style of convex lap (Fig. 4) I know would require "an amount of patience and perseverance that would make a Jap turn green with envy." It is bad enough to make a straightedge, but when you come to make a square edge at the same time I don't see how he could do it on that lap. And that test bar of "chilled white iron" might have been slightly concave or convex instead of straight; it would have stood the test of cotton fiber that he tells about just as well.

A lap that won't make a six- or seven-inch proved steel straightedge ought to be planed off, then scraped to a surface plate as flat as you can get it. If it is slightly convex it will help you in lapping *flat work*, which is inclined to curl away from the lap when being lapped, causing the ends to become thin when the work is lapped on both sides. But in making a proved straightedge the lap must be as flat as possible.

It is a known fact that if three surfaces fit each other, as proved by placing any two of them together, the surfaces must be straight.

Take a piece of ¼ by 1½ by 7-inch tool steel, bevel one edge down to about 1/16 inch thick, then harden it back about a quarter of an inch on the narrow edge, then draw it to a straw and grind all over. This wide edge, a knife-edge and the lap make three surfaces that have to fit each other or I don't want the lap for fine straight lapping.

To prove the lap flat take the wide straightedge, place it against a parallel to hold it from rocking and go all over the lap (after charging with abrasive); then take the knife-edge (without the parallel) and do likewise. Now you have two opposites of the lap and if they fit one another every time you lap them on the same lap they must be straight and the lap flat, and if there is an error it will show double the error of the lap.

I have lapped a good many straightedges and knife-edge squares on laps that would stand this test and have never been bothered with heat expanding or distorting the straightedge.

Lapping is nothing more than refined peening. Take a piece of cast iron 1½ by 1½ by 7 inches, scrape it to a surface plate on two sides and give a few rubs on a charged lap, on one side. The cast iron piece will curl and about as quick as though it were hit with a hammer on the same side that you have just lapped—and they say: "Don't hammer stock." A lap will also curl hardened steel, although I have worked steel that the emery wheel or lap did not seem to affect.

Carborundum makes a good abrasive. Keep your grades that will not sift through cheese cloth, in tin pepper boxes, also your cheese cloth bags in marked tin boxes. I can't see how Mr. Gardner charged his lap on the same charging plate for the finer grades after using coarse grade.

Mr. Gardner speaks about the wear upon the charging block and lap that I agree with. It is caused by the abrasive rolling between the two plates and has the same effect as a knurling tool (but of course not so pronounced).

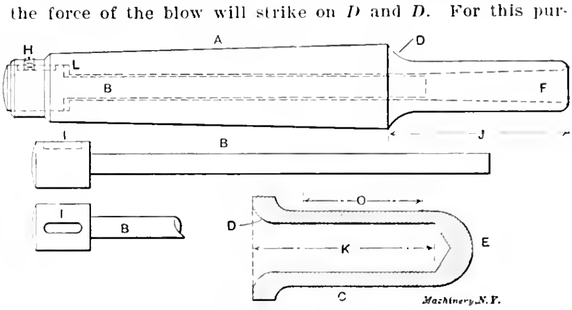
To overcome it I use a hardened piece of steel to charge the lap with. I find there is too much rubbing done in recharging a lap. You can charge a grey iron lap the best by using a few drops of kerosene, then sift the abrasive onto the lap through the cheesecloth bag; use enough benzine to spread the charge. Use another piece of cheesecloth for the rubber. This leaves a thin film of kerosene oil and abrasive that seems to make steel melt away, it cuts so fast.

You can lap an oil stone on a lead lap flat enough to do a surprisingly good job for roughing the straightedges. When lapping a glass test bar remember that high finish and accuracy do not travel together. The seemingly rough surface will be more accurate than a scratchless, high-finished one to work with.

Laps thinner than two inches thick are liable to distort when used much. You will be deceived and lay the trouble to the lap wearing through use, but if charged right it will stand a good test after a year's constant use. SCOTTY.

MILLING MACHINE COLLET.

The cut shows a handy collet to be used in a universal or hand milling machine. The taper hole F in the collet is made to fit standard tapers; a straight hole is drilled and counterbored in the rear end to receive the knockout plug B. B is an easy fit in A and is held from working out by the screw H and the elongated slot I. The thimble C is made a loose fit over the neck of collet A and is used to drive the collet into the spindle. Distance K is a little longer than distance J, so the force of the blow will strike on D and D. For this purpose the radii of D and D are made the same. The end of C at E is rounded to centralize the blow when collet A is driven into the spindle. C is knurled for the distance indicated at O and it is spring tempered. By this construction as many cutters can be used as needed without removing collet A from the spindle. Jammed and sprung collets that always run out of true are also done away with. Of course the collet can be removed by driving the knockout plug further in until it shoulders against L. E. W. NORTON.



Milling Machine Collet.

* * *

DANGER OF RELYING ON SECRECY TO PROTECT A PROCESS.

Some years ago the Goldschmidt Co. of Essen, Germany, perfected a process of detinning tin scrap but instead of patenting the process they depended on secrecy to make the discovery profitable. The usual result of such practice followed. Two of the employees knowing the secret, proved unfaithful and sold their knowledge to a concern which commenced the work in Holland and from there it was brought to America. The American concern in turn were served in the same manner. The result was that undesirable competition was established by two plants, one at Paulsboro, N. J., and the other at Joliet, Ill. The company first on the ground in this country commenced suit against the competitor seeking to enjoin them from using the knowledge obtained through the defection of one of their employees. The case was thrown out of court as the court would not stain its hands with such disreputable proceedings, none of the parties having good standing. The operation of a plant on the principle of secrecy puts a premium on dishonesty. The patent laws of most countries offer adequate protection for most inventions and discoveries; if that protection is not sought, but rather that of secrecy, the possibility of recovery of damages in case the secret is stolen by competitors is very slight indeed.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO TRUE UP OILSTONES.

Sprinkle coarse grain emery or corundum, over a planed cast-iron surface, then rub the stone over this by hand. This will true up the face of any kind of an oilstone sooner than any other method I have ever tried. L. E. MUNCY.

Syracuse, N. Y.

TO DRILL HARDENED STEEL.

Thin steel, such as saw blades that are very hard, can be drilled with comparative ease by keeping the center punched down with a center-punch and grinding the drill nearly flat on the end. Run at slow speed with considerable pressure, and dry. MILTON BURGESS.

Cleveland, O.

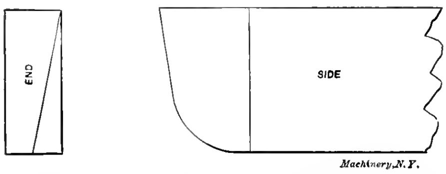
TO MAKE A SIMPLE CASTING FROM A BROKEN ONE.

To make a simple casting of precisely the same size as a broken one without the original patterns, put the pieces of broken castings together and mold them and cast from this mold. Then anneal the new casting by heating it in a slow charcoal fire to a dull red heat, and then covering it over about two inches with fine charcoal with plenty of dry ashes on top. Let it lie until cold. The annealing treatment will permanently expand it to the original size; it also makes a casting that is less liable to break. J. W. WILFORD.

St. Joseph, Mich.

TO TURN RUBBER.

To turn soft rubber such as typewriter rollers I use a very sharp tool as shown in the cut, and run at a rather fast speed



with feed about 1/16 inch per turn and finish with sand-paper. It makes a very much better job than one would think.

Cleveland, O. MILTON BURGESS.

TO DETECT A SOUND IN A NOISY SHOP.

It is very important, when a machine in motion produces the peculiar noise, indicating that some parts are cutting, to locate the trouble immediately. Sound is produced first, and then heat. Sometimes when the parts get hot, it is too late to remedy the trouble, as they may be so badly cut that they are ruined. To detect the sound quickly, before much heat is produced, apply to the ear one end of a rubber tube, and move the other end about to find the precise point the noise comes from. Stopping the other ear helps. I employed this way of detecting a sound in a very noisy shop, with success, several times. Try it and you will be surprised at the result.

Los Angeles, Cal. J. M. MENEGUS.

TO REDUCE THE SIZE OF A HOLE IN WROUGHT IRON, STEEL OR CAST STEEL PIECES.

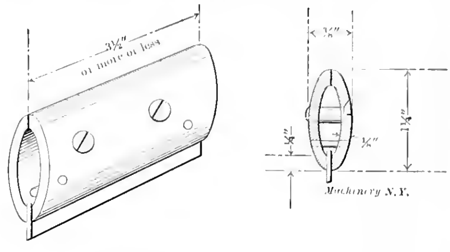
When a hole has been bored out too large by mistake, if the shape of the piece will allow, the following method may be used to reduce the size of the hole:

Heat the piece redhot, and plunge it half way in cold water, taking care to keep the axis of the hole perpendicular to the surface of the water. Half of the piece will become cold and shrink. The other half that is still red will shrink while hot, being pulled together by the cooled part, and when it gets cold will shrink still more, becoming smaller than the original size. Heat the piece again and plunge it in water as before, taking care to plunge the end opposite to the one that was plunged before. Repeat this operation, dipping the two ends of the piece in water, alternately until the size of the hole has been reduced enough to allow a nice cut to be taken to bore it to the right dimension. J. M. MENEGUS.

Los Angeles, Cal.

A USE FOR BROKEN AND WORN-OUT HACK-SAW BLADES.

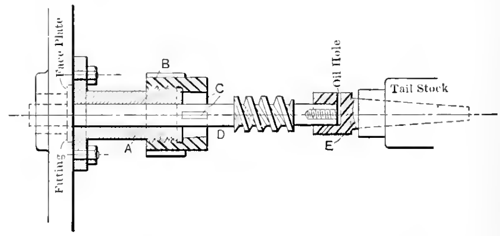
A useful scraper for wood is made as shown in sketch. The handle is shaped as shown from steel or brass. The dowels hold the parts of the handle in line, and prevent the blades from slipping; they also locate the blades. The blade being very thin can be easily sharpened and kept sharp. It makes



a most useful patternmakers' or joiners' scraper, and the blades cost nothing to replace, broken or worn-out hacksaw blades being used for the purpose. A rough and ready handle can be made by sawing a narrow slit in the end of a piece of hard wood and driving in the blade tightly. HARRON.

THREADING COMPOSITION STEMS.

Mr. Eberhard's article, "Drill Press Centering Device," in the January issue calls to my mind another way of threading composition pieces, very similar to his. We also had several hundred stems in number, and the same troubles, one end being tapped. The accompanying sketches show how we got out the job.



A is a cast-iron piece fitted and bolted to the face-plate of a lathe, and bored the same size as the stem. The outside is threaded and turned taper for the steel nut *B*. The end of the piece *A* is split as shown at *C*, the length of the taper. As is readily seen, the nut, being screwed with a spanner, causes the split taper end of the piece *A* to close and firmly hold the stem *D*. *E* is a special steel center bored the same size as the stem. Using this device the composition pieces were threaded in a very satisfactory manner. J. M. MENEGUS.

Los Angeles, Cal.

TOOLS FOR SETTING MILLING MACHINE VISE SQUARE, AND PARALLEL WITH THE SPINDLE.

The device shown in Fig. 1 has been nicknamed the "wing-wang" in our shop, and is used for setting a milling machine vise square with the spindle. It is made of machine steel

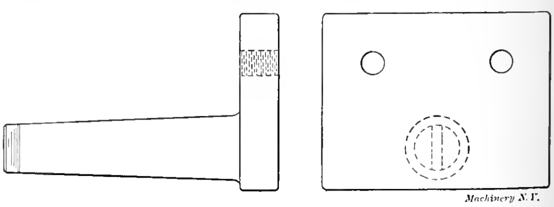


Fig. 1.

turned with the face square with the shank and is fitted to the taper hole of the spindle of the milling machine. The one we have is $4\frac{3}{8}$ inches long, $\frac{3}{4}$ inch thick and $3\frac{1}{4}$ inches wide.

It does away with the cut-and-try method of setting a vise with the indicator gage, and saves much time. The way it is used is simply to mount it in the spindle with the wing down and then the swivel clamping screws of the vise are loosened and the front jaw moved forward until it touches the wing; then the vise is screwed together and the clamps are tightened. This simple operation squares the vise with the spindle, whereupon the "wing-wang" is removed.

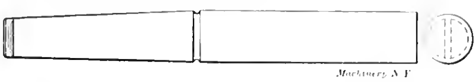
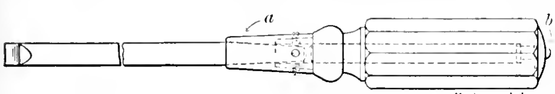


Fig. 2.

Fig. 2 shows a mandrel for setting the milling machine vise with the jaws parallel to the spindle. It is about 1¼ inch diameter with a taper shank to fit the spindle and projects about 12 inches from the spindle when in place. To use it the vise is strapped to the platen and the swiveling screws are loosened; then the vise jaws are opened and the table is raised so that the jaws may grasp the arbor, whereupon they are tightened upon the mandrel and the clamping screws are tightened; loosen the jaws and remove the mandrel and you are ready for work. O. WESTBERG.

SCREW DRIVER WITH KNOCKOUT PIN.

The cut shows a neat screw driver for all-around shop use for which a number of blades can be conveniently used with one handle; it was introduced into the shop by one of our toolmakers. To make it, procure from a hardware store a rosewood handle of the style shown in the cut and make a steel cap which is bored taper in the front end and is held in position by four screws. These screws project into the bore and fit against a square which is ground on the end of



each screw driver blade. In the handle a ⅜-inch hole is bored from one end; and from the other end a ¼-inch hole, which is counterbored to ½ inch diameter and 3/16 inch depth. In this is fitted a steel bushing. The pin *b* is made a loose fit in the handle. The blades, which may be made of any size drill-rod, are turned to fit the handle. They are removed by simply knocking the end of the handle on the bench so that the pin *b* loosens the blade. O. WESTBERG.

MAINSPRING KINKS.

No spiral mainspring should have a kink in it, but there are one or two kinks in reference therewith, which are worth learning and remembering. The first is in relation to broaching the hole by which it is pinned to the barrel or other part which it rotates, or which serves as an abutment to enable it to drive another part. Usually this hole is broached at right

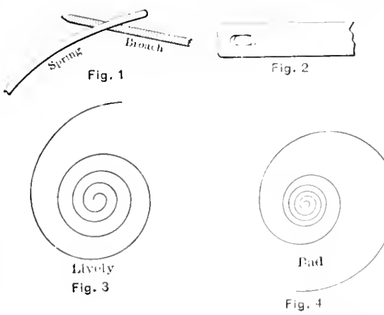


Fig. 1 Fig. 2 Fig. 3 Fig. 4

angles to the face of the spring. But if the hole be made obliquely through, as shown in Figs. 1 and 2, it will give a sharp edge on the holding side, which will get a much better grip on the pin, stud or hook, than where the hole is circular and all its edges at right angles instead of acute on one side and obtuse on the other. Of course the sharp edge is to come where it will bite the hook or pin.

The second kink is in choosing a mainspring which shall be "lively" and the pressure of which shall increase uniformly. Reference to Figs. 3 and 4 will show what kind to choose. Fig. 4 is the way that a slow and irregularly acting spring will look when allowed to lie free on a table; Fig. 3 is the way that it should lie. Consequently in choosing a spring, where it is desired that the response shall be lively and the pressure diminish in a regular ratio instead of in the one that is variably decreasing, one should be picked out that lies like Fig. 3.

Hannover, Germany. ROBERT GRIMSHAW.

CAST-IRON GAGES.

In making up large plug gages it is a usual custom to make them out of tool steel, hardened and ground, but I find that fine gray iron, carefully turned and ground, gives good satisfaction and lasts a long time; besides cast iron lends itself to cored construction which lightens the gage. It is also convenient to change the handle from one to the other, in case there are different sizes. Fig. 1 shows a straight plug 3 inches

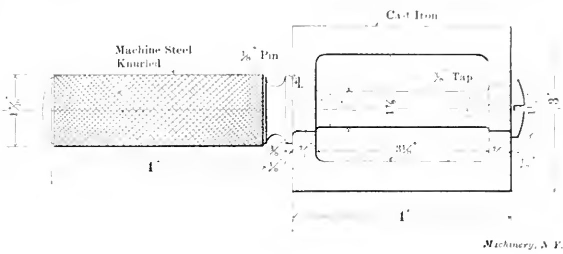


Fig. 1

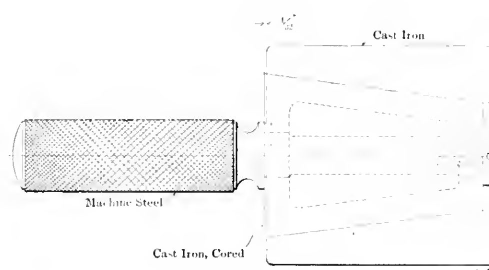


Fig. 2.

diameter, and Fig. 2 shows a taper plug and shell gage, using the same handle. In making taper rods and taper holes the gages are used as follows: The plug is allowed to extend out of the hole 1/32 inch after reaming, and if the rod is fitted to within 1/32 inch of the shell, when they are tightened together, it will be about right to give them a good seat. Usually for brass I allow a little more than 1/32 inch.

I. N. QUIRL.

TO SOLDER SMALL PIECES TOGETHER—NOTES ON SOLDERING.

To solder several small articles together that are hard to keep in place, bind them together with aluminum wire. The wire can be easily removed after soldering as the solder does not stick to aluminum. It is much easier to solder iron or steel pieces together if each surface is coated with solder beforehand.

To re-tin a badly burnt soldering copper, file or grind till flat and bright, then place some pieces of coarse emery cloth and rub briskly with the soldering copper when hot.

For soldering brass or copper the soldering pastes on the market are far more satisfactory than acid and do not corrode the work. MILTON BURGESS.

Cleveland, O.

SMOOTH SCRAPING ON STEEL.

Dip the scraper in turpentine when scraping steel and you can produce good results much more easily than when used dry. JAMES A. PRATT.

Howard, R. I.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

172. PREPARING FINE OIL FOR DELICATE MACHINERY.

Put small zinc and lead shavings in equal quantities into best olive oil, and place the oil in a cool place until it becomes colorless. This oil is the best obtainable for fine mechanism.

O. G.

173. TO WRITE WITH COLOR ON A DRAWING THAT IS TO BE VARNISHED.

When it is required to color or to write with color on a drawing or blueprint which has to be varnished later, mix a little isinglass with the color; this will prevent the color running when the size is applied.

H. L. MILLAR.

Manchester, England.

174. BLACK VARNISH FOR IRON.

A good black varnish for cast iron and forgings can be made of ¼ pound lamp black; ½ pound resin; 1 pound asphaltum; 1 quart turpentine spirits; and a small quantity linseed oil. The lampblack is first rubbed up with the linseed oil, no more oil being used than necessary for this purpose. The other ingredients are then mixed with it thoroughly.

O. G.

175. IRON CEMENT.

The following iron cement, if properly prepared and applied, will unite broken iron parts very strongly, and may be found useful oftentimes for repairing broken machine parts of comparative unimportance. Mix equal parts of sulphur and white lead with about one-sixth part of borax and incorporate the three together thoroughly. When ready to use the mixture wet it with strong sulphuric acid and spread a thin layer of the cement on the joint to be united. Clamp together for five days when the joint should be dry and sound.

St. Joseph, Mich. J. W. WILFORD.

176. TO FINISH WOODEN HANDLES, GUN STOCKS, ETC.

The wooden parts of tools, the forearms and stocks of guns, etc., are often made to have a fine appearance by French polishing, but this finish adds little or nothing to their durability. A much better finish is to soak the wood in linseed oil for a week and then rub it with an oil-soaked cloth a few minutes every day for a week or two longer. This solidifies and preserves the work.

A. L. MONRAD.

New Haven, Conn.

177. TO COAT BRASS OR COPPER WITH TIN.

To tin brass or copper melt 5 pounds of tin and pour same into a tank containing one ounce of cream of tartar in about 8 gallons of water. This must be done a drop at a time to subdivide the tin so as to give a larger surface for the cream of tartar to act upon, and have the bottom of tank covered with tin. Then put a fire under the tank and place parts to be tinned in the tank and let them boil for about one hour, or until they are coated sufficiently.

H. C.

178. CHEAP CEMENT FOR GENERAL USE.

To make a cheap cement for general use, mix gum acacia (pulverized), 1 ounce; French isinglass, 2 ounces; vinegar, 4 ounces; essence of sassafras, 5 drops. After mixing allow it to stand for 12 hours, then heat until thoroughly dissolved when it is ready for use. For covering pulleys with leather, paper, etc., add ½ ounce glycerine to one quart of cement; heat and use while hot. Oily belts can be successfully spliced with this cement by rubbing the scarfed ends with powdered sal-soda and applying a coat of cement, which is allowed to dry; then apply a second coating and put together.

J. H. V.

179. TO BLACKEN TIN FOR LAYING OUT.

Very often in the shop and also in the drawing room we want to lay out some piece of work for trial on something which will show fine accurate marks, but cannot obtain a piece of sheet zinc. I have used something which is just as good and more likely to be at hand, and that is a sheet of bright tin plate rubbed over with a piece of waste dipped in a sulphate of copper solution. This is made of water and blue stone with oil of vitriol added in the proportion 1 of vitriol to 50 water. Rub the tin thoroughly, keeping the waste wet with plenty of fresh solution and soon you will see spots of brass, then of copper, then a dark gray, nearly black, which wipe dry, and you will have an ideal surface to lay out on.

The above is a kink which I have found very useful.

Ilion, N. Y. F. W. BACH.

180. LUBRICANT FOR THE V'S OF LARGE PLANERS.

When very heavy work is to be done on a planer it may happen that the oil or other lubricant used on the ways of the planer does not possess sufficient "body" to resist the pressure and the wearing surface will be cut or badly "roughed up." The writer had a case wherein the planer table weighed eleven tons and the load to be put upon it thirteen tons, making twenty-four tons in all. The bearing surfaces of the V's appeared very narrow to successfully support such a weight. To avoid cutting, the surfaces were lubricated with a mixture of one gallon of "Vacuum" cylinder oil and one pound of Dixon's flake graphite. The planing job was easily and successfully done with no injury to the wearing surfaces.

Neponset, Mass. OSCAR E. PERRIGO.

181. ACIDS FOR ETCHING.

Soft Steel.—Nitric acid, 1 part; water, 4 parts.

Hard Steel.—Nitric acid, 2 parts; acetic acid, 1 part.

Deep Etching.—Hydrochloric acid, 10 parts; chlorate of potash, 2 parts; water, 88 parts.

Etching Bronze.—Nitric acid, 100 parts; muriatic acid, 5 parts.

Brass.—Nitric acid, 16 parts; water, 160 parts. Dissolve six parts potassium chlorate in 100 parts of water, then mix the two solutions and apply.

Where the name, initials, or monogram is etched on a tool, for instance a square blade, black asphaltum varnish makes the best "resist." Have a rubber stamp made with the design you wish to etch and stamp the tools with the same using the varnish as you would ink on the stamp, the stamp having a fancy border around the outside edge. This method leaves the letters or design in relief and makes an unique appearance.

E. W. NORTON.

182. TO BLEACH BLUEPRINTS.

It is occasionally necessary to bleach blueprints when it is desired to make drawings for photographic reproduction. Blueprints are sometimes so faded that it is impossible to trace them, in which case I ink the lines of the blueprint and then bleach out the blue leaving the black lines on the white ground. The process of bleaching is extremely simple and is one that I developed about eight years ago. I had found it impossible to make tracings from blueprints which were very much faded, or which had been over- or under-printed. After experimenting for a month or so, trying different preparations, I finally hit on the following combination: 1 gallon lukewarm water and ½ pound bicarbonate of soda. Of course this proportion is not exact, and has to be used with caution; when in doubt prepare a little solution and make a test of a small piece beforehand as it will be found that some prints will not bleach as others do. Do not allow the inked-in prints to remain in the solution any longer than is absolutely necessary for no matter how waterproof the ink may be it is impossible to keep it from running a little. Freshly made blueprints, that is, those not more than a few months old, work best. As soon as the print is bleached take it out of the solution by the corners, being careful not to touch the ink work. Too much soda is harmful as it deposits white dust on the lines. This, however, can be removed by re-immersion in clean water.

FRED DIBELIUS.

New York.

* * *

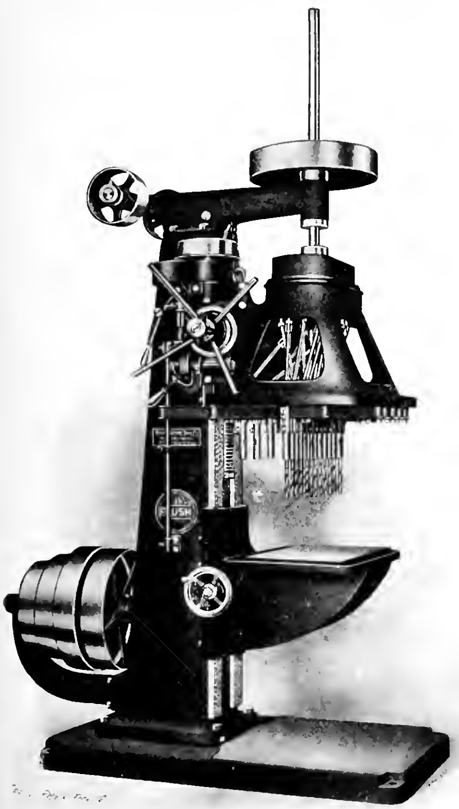
Don't be contented with being merely a lathe man, or planer man, but aim to be what is termed "an all-around man"; then you will stand a much better show of being promoted.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

ADJUSTABLE MULTI-SPINDLE DRILL.

The half-tone shown herewith illustrates an adjustable multi-spindle drill designed especially for repetition work on automobile crank cases, cylinders, pumps, etc., and electrical slate work. The machine is of the construction which employs a movable head carrying a number of drill spindles attached to adjustably slotted arms, the separate spindles being driven from the geared head through a series of universal joints. This arrangement permits the drills to be arranged to follow a circle, square or any rectangular layout within the capacity of the head. The spindles themselves are of tool steel with ball bearings for thrust running in bronze bushings, and have a vertical adjustment on the arm. The head on which they are carried may be made round or rectangular, or any



Baush Adjustable Multi-spindle Drill.

shape desired to suit the general run of work in the shop where it is to be used; the size of the head may also be varied together with the number and size of the spindles supplied with it. The cut shows a No. 10 machine fitted with the largest head which can be supplied for this size of machine, and, by using the smallest size spindles, 16 holes may be drilled at one time, varying from 3/16 to ½ inch in diameter. The least distance under these conditions from center to center of spindles would be 1¼ inch, while the longest layout between centers of the extreme spindles would be 16 inches to 20 inches. It will drill 16 one-half inch holes in cast iron 1 inch deep in 20 seconds, either using high speed or carbon drills as may be desired, a two-speed countershaft being furnished for this purpose. The head is counterbalanced and to it is applied the power feed which has three geared changes and a quick return mechanism. It has also an automatic knockoff which enables the operator to drill a hole of any required depth. The table may be raised or lowered on the column for adjustment by means of the hand wheel shown at the left. The base of the machine is planed so that if it is required to drill work of extreme length, the table can be removed and the work be directly clamped to the base. The table is 18 inches by 24 inches, and the net weight of the machine with countershaft is about 3,600 pounds. The Baush Machine Tool Co., Springfield, Mass., are the builders.

SMALL ELECTRIC BENCH DRILL—ELECTRIC BREAST DRILL.

We show herewith two of a series of small electrically-driven tools recently developed by the General Electric Co., whose main offices are at Schenectady, N. Y. That shown in Fig. 1 is a bench drill particularly designed for the use of jewelers, repair men, and manufacturers who have a large amount of drilling to do of a kind that does not require severe service. The motor and drill spindle are mounted together in

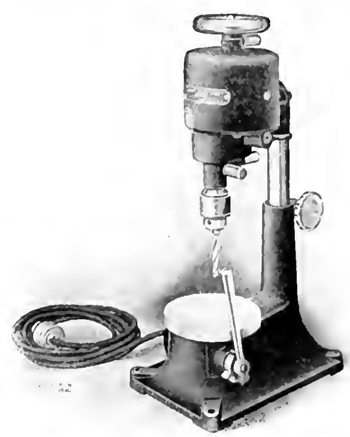


Fig. 1. Small Electrically-driven Bench Drill.

a head which is adjustable for height in the standard at the rear of the base. The motor is of the vertical type and furnished with self-oiling bearings and drives the spindle through a single gear reduction. The handwheel mounted on the armature shaft at the top is convenient for turning the spindle and gives the apparatus a flywheel effect as well, thereby ensuring a smooth and steady rotation of the drill. The motor is series wound and can be supplied with 115 or 230 volt winding for use on direct current circuit only. The

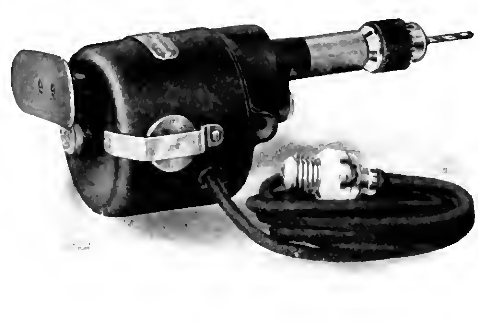


Fig. 2. Electrically-driven Breast Drill.

outfit includes 10 feet of attaching cord and an Edison attaching plug. The largest drill the chuck will hold is 21/64 inch diameter. The work is fed to the drill by raising the circular table, which has a movement of 1¼ inch vertically. The motor has 6 inches vertical adjustment. The whole outfit weighs about 40 pounds and rests on a broad base 6 inches wide by 10 inches long. The outfit is finished in black japan with nickel-plated trimmings.

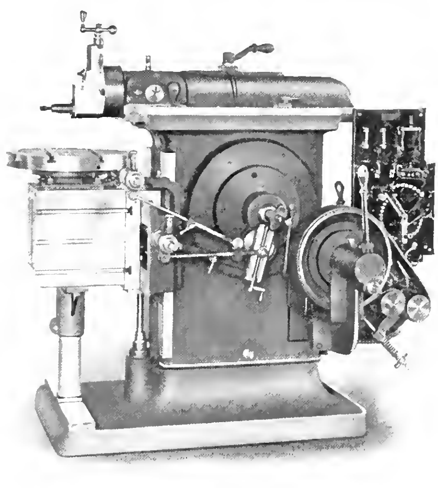
The breast drill, shown in Fig. 2, is similar in capacity and

design of motor to the bench drill just described. The oiling of the bearings is effected through protected oil holes which replace the self-oiling features of the bench drill motor. The self-oiling bearing is not practicable with this drill since it is used in all conceivable positions and oil could not be prevented from escaping from the reservoirs. The tool is provided with a suitable switch on the body of motor so arranged as to bring the drill under the instant control of the operator. The switch is well protected from damage and strongly constructed. With the outfit is furnished chuck and extension cord with Edison attaching plug, permitting a radius of action of 10 feet from the source of the current supply.

Among the other interesting small motor driven tools recently developed by the General Electric Co. might be mentioned a domestic grinding and buffing outfit which consists of either a direct or alternating current motor, as the case may require, of suitable power and speed, and furnished with buffing and grinding wheels. These outfits are useful for grinding knives, scissors and other similar edged tools, and for polishing small silverware, jewelry, etc. They are furnished for 110 volts direct current and 110-volt alternating current, or in special cases, for 220-volt alternating current. The direct-current motor weighs but 15 pounds; with alternating current the outfit weighs about 25 pounds. The tools are adapted for the intermittent service required in the ordinary household but are not suitable for the heavier and continuous work which is required by jewelers, dentists, etc. Other and larger outfits are furnished by the manufacturers for this more exacting service.

CIRCULAR TABLE FOR THE STOCKBRIDGE SHAPER.

The accompanying halftone shows a circular attachment that has recently been applied by the Stockbridge Machine Co., Worcester, Mass., to one of their 16-inch crank shapers. As shown, it consists of a rotary table driven by a worm engaging with a wormwheel formed on the under surface of the table, which may be rotated by a ratchet feed derived from



Stockbridge Shaper with Circular Table.

the same source as the regular cross feed of the table. The feed is so arranged as to permit the operation of the cross feed and the circular feed at the same time, or the use of either one separately. The feed is adjusted by means of a sliding block operated by a screw, and the adjustment can be made while the machine is in operation.

CRESCENT ANGLE BAND SAW.

The Crescent Machine Co., of Leetonia, Ohio, are introducing an angle band saw which presents some novel features. The most noticeable difference between this machine and the standard type is in the way in which the blade is adjusted in relation to the table to saw on an angle. This is ordinarily done by tilting the table up to the required amount, the wheels being fixed in position, the saw itself remaining vertical. In this machine, however, the table is always horizontal. When it is desired to use the angle cutting features, the hand wheel shown at the front of the table is revolved. This tilts the frame carrying the band wheels backward on the lower wheel center as an axis, thus inclining the saw to the table to any extent desired. At the same time that this is

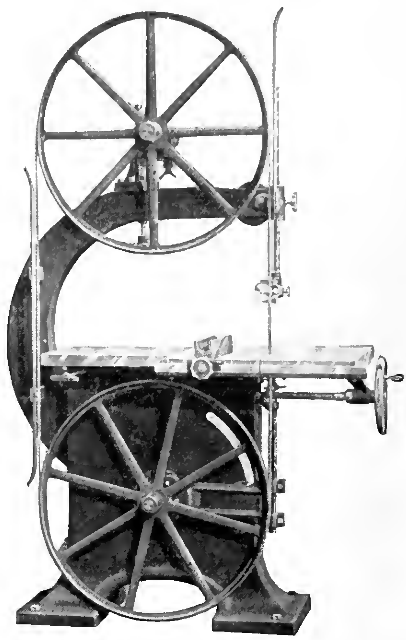


Fig. 1. Crescent Angle Band Saw in Vertical Position.

done the table is moved backward the proper amount to keep the saw in register with the saw slot. This travel of the table is taken care of automatically, so there are no sliding throat blocks to push into position. If desired the machine may be tilted while the saw is cutting. This feature is useful for boat work and other work of a similar character. The guides keep the proper alignment without attention. The

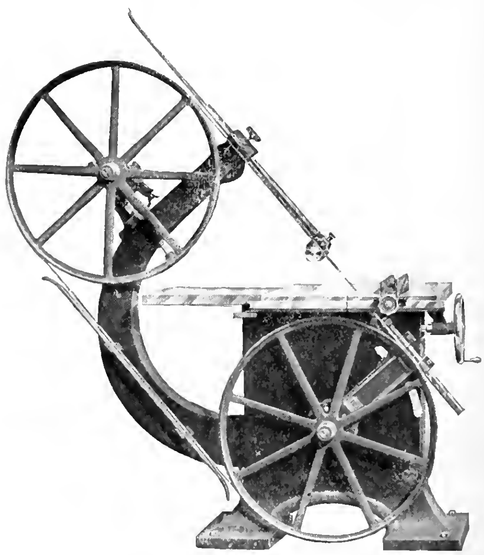


Fig. 2. Crescent Angle Band Saw in Tilted Position.

arm is suitably counterbalanced so that the handwheel turns easily. Extreme simplicity is also claimed for the machine, there being but a few more parts used than on the common type of bandsaw made by the same manufacturers. The novel features of the machine are covered by patents recently issued.

THE "SIM-PULL" COUNTERSHAFT.

In the half-tone, Fig. 1, and the line cut, Fig. 2, are shown the design and construction of a countershaft with an interesting belt shifter, manufactured by the Mossberg Wrench Co., Central Falls, R. I. In the construction shown in the half-tone the device is self-contained in one hanger and comprises a tight and loose pulley shaft, and a driving pulley for the machine, together with the mechanism by which the belt is shifted. This latter is shown more clearly in Fig. 2. The machine is started and stopped by pulling a cord attached to the pendulum slide *G* which is normally held in the position

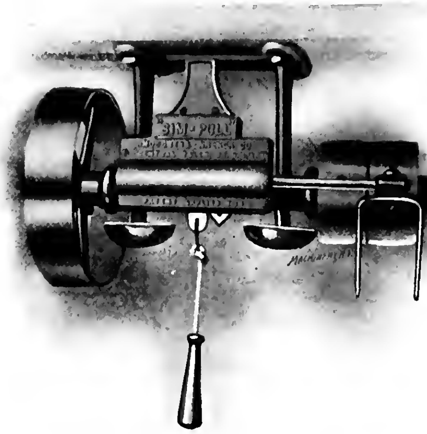


Fig. 1. "Sim-Pull" Countershaft.

indicated by a spring not shown in the cut. Projection *F* on this pendulum slide furnishes an abutment for the shipper slide at *D* and prevents the same from moving. When the cord is pulled, however, drawing *G* downward in a vertical direction, projection *F* is withdrawn so that the shipper slide is no longer locked in position. A continued downward movement of *G* lowers the pendulum *A* which engages with cam *B*, and by it is swung to one side, engaging and shifting the shipper slide *C*, and with it the belt. At the end of this movement slide *C* strikes cam *B* and moves it as shown by the dotted lines so that the next time the cord is pulled pendulum *A* will be swung in the opposite direction, returning the shipper and its slide to the position shown in the cut. If, by carelessness on the part of the operator, the slide *G* is not pulled down to its full extent, in its return projection *F* engages with either of the inclines *H* or *I* as the case may be and wedges the shipper slide to one extremity of its throw or the other. This provision makes it impossible for the shipper to stop half way between the off and on position. In either position it is of course effectively locked by the

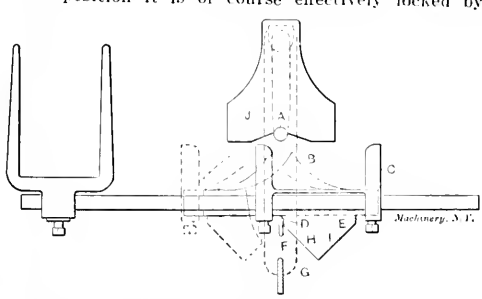


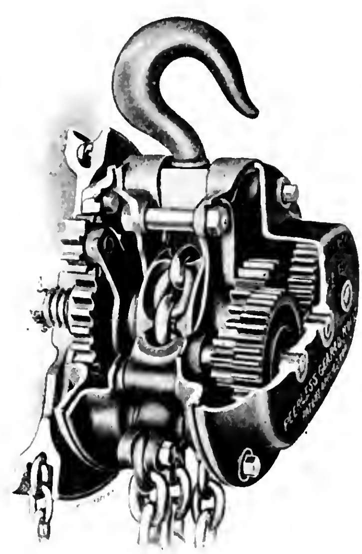
Fig. 2. Showing Construction of "Sim-Pull" Countershaft.

projection *F* engaging with slide *D* or *E* of the projection on the shipper slide. At each return of the pendulum it is guided to and located in its proper starting position by the form on the bottom edge of plate *J*. This countershaft is made in six sizes, for tight and loose pulleys ranging from 4 inches in diameter by 1¾ inch wide to 9 inches in diameter by 4¼ inches wide, the smaller sizes being supported by one hanger with the pulleys supported between them if so desired. The loose pulley on these countershafts is bushed with an Arguto oilless bearing, thus requiring no oiling.

PEERLESS HOIST.

The "Peerless" is a recently designed hoist of the spur gear type, embodying a number of new devices. The good qualities obtained in the design are safety, durability, speed and power. The internal mechanism is quite plainly shown in the cut, which is reproduced from a photograph of a hoist which has been cut open to show the mechanism. The main train of gearing consists of a double set of compound balanced steel spur gears, machine cut from drop forge blanks. These operate the hoisting chain drum which is concentric with the hand wheel shaft but revolves in separate bearings in the frame. The gearing arrangement insures an equalized bearing on the surface of the teeth, reduces wear to a minimum, and gives a free and smooth action to the hoist.

The function of sustaining the load is performed by two friction disks with a leather washer between them mounted on the hand wheel shaft next to the wheel. The hand wheel is screwed upon the threaded hub on one disk, and in hoisting clamps both disks tightly together. The threaded disk is keyed to the shaft. The other disk has teeth cut upon its outer periphery as shown and is loosely mounted upon the hub of the first one. The teeth in this disk engage those of a small pinion which is mounted on a freely rocking arm which encircles the hand wheel shaft and is pivoted below it. The teeth of this gear and pinion are of such a form that they revolve noiselessly and freely in the direction which is taken by the hand wheel when the load is raised. When the raising ceases the load tends to revolve these gears in the opposite direction but owing to the peculiar shape of the teeth, the small pinion is unable to revolve and consequently the rocking arm is thrown backward until a steel dog formed in the cover plate engages with the pinion and thus effectually locks the hoisting device and prevents the load from descending of its own weight. When, however, the operator desires to lower the load, a pull of the chain in the other direction unscrews the handwheel for a portion of a revolution on the threaded hub of the friction disk on which it is mounted. This disengages the frictions and allows the hand wheel shaft to rotate within the toothed friction disk, thus permitting the load to descend. Whenever the backward motion of the handwheel ceases, the disks automatically tighten by being screwed together by the moving load, which is thus stopped. Any possible danger of the load chains slipping is eliminated by an improved arrangement of chain guard and stripper. A flaring hand wheel guard is provided which permits the operator to stand at one side without having the chain drag in the guard. It is built by Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa.



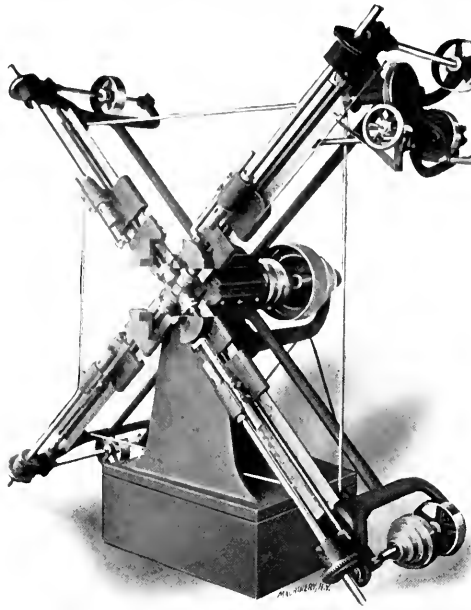
Peerless Hoist.

FOUR-SPINDLE DRILL.

The cut herewith is of a four-spindle drill designed to drill flanges or tubing. All four spindles are arranged to drill to the center and each drill head is gibbed to a radial arm and can be adjusted in or out to permit holes to be drilled in a circle ranging from 3 to 40 inches in diameter. The pipe or flange to be drilled is held by an internal chuck consisting of

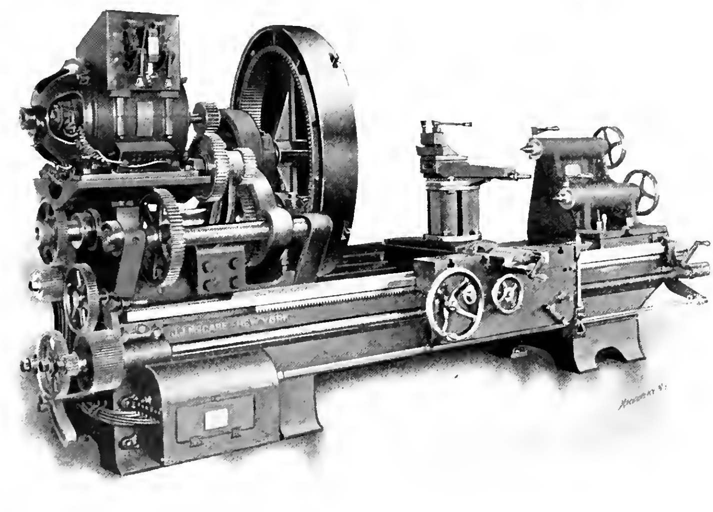
four sliding heads which also move in or out on the radial arms, as clearly indicated in the engraving.

The drilling heads have automatic screw feeds and separate adjustment to allow for drills of different lengths. The feeds for the four spindles are obtained from a four-step cone pulley which supports a worm and worm gear and through which power is transmitted to one of the feed screws. This



Four-spindle Drill.

screw has a pinion at its inner end, near the center of the machine, which drives similar pinions on the inner ends of the three feed screws, by this means transmitting the feed motion for the other three heads to these several gears. There is also provision for feeding the spindles by hand, a crank for this purpose being plainly shown on the right-hand upper radial arm in the engraving.



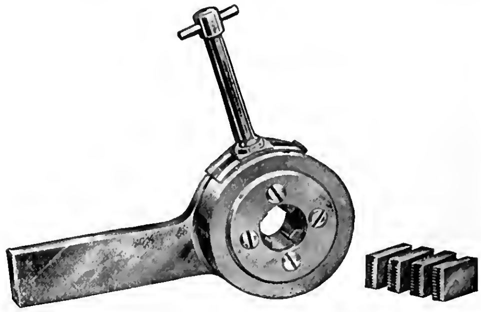
Motor Equipment for McCabe Lathe.

The machine itself is driven by a three-step cone pulley on the countershaft at the rear of the machine; and on this shaft are the four pulleys from which radiate the belts to the four pulleys on the extreme ends of the radial arms, and from which the several spindles are driven.

With each spindle is an adjustable drill gage to properly center the hole. The feed also has an adjustable automatic stop to enable holes to be drilled to any given depth. This machine is built by the Hoefer Mfg. Co., Freeport, Ill.

LATHE DIE STOCK.

The Standard Machinery Co., Bowling Green, Ohio, have designed a lathe die stock for cutting accurate threads on pieces held between the lathe centers. It is clamped in the tool post of the lathe and may be used in connection with the lead screw if desired, the thread being cut at one operation. By the use of the lathe chuck rough bolts can be threaded the



Lathe Die Stock.

same as in a bolt cutter. The tool is made in two sizes, the smaller of which will cut threads from 1/4 inch to 1 inch in diameter and the larger of which will cut up to 1 1/2 inch in diameter. There are four dies to a set and the change from one size to another can be made quickly. Threads under and over size can be cut by means of an attachment which provides a simple means for adjusting the die.

MOTOR EQUIPMENT FOR McCABE LATHE.

A standard mounting for motor equipment for the McCabe double-spindle lathe has been adopted by the builder, J. J. McCabe, 14 Dey St., New York. The motor sets on a table supported by brackets above the head stock and the lathe is driven through a train of reducing gears, which transmit motion to the large cone gear of the lower lathe spindle. The equipment illustrated consists of a seven horsepower variable-speed direct-current motor which runs at 350 revolutions per minute at its lowest speed and has a range up to 1,750 revolutions per minute through twenty steps in the controller. While nominally of seven horsepower, the motor is capable of heavy overloads and can be operated for two hours at 25 per cent overload without overheating. The controller is a full reverse drum type placed on the floor at the front of the head stock with its spindle geared to a splined shaft extending along the bed and operated by a crank with an index pointer and dial on the lathe carriage. The circuit breaker is mounted on a slate slab conveniently placed in front of and above the motor. The purchasers of the lathe may supply their own motor, if desired, as the lathe can be furnished with the table and brackets and the necessary gearing for connecting with any type of motor, including the alternating-current type.

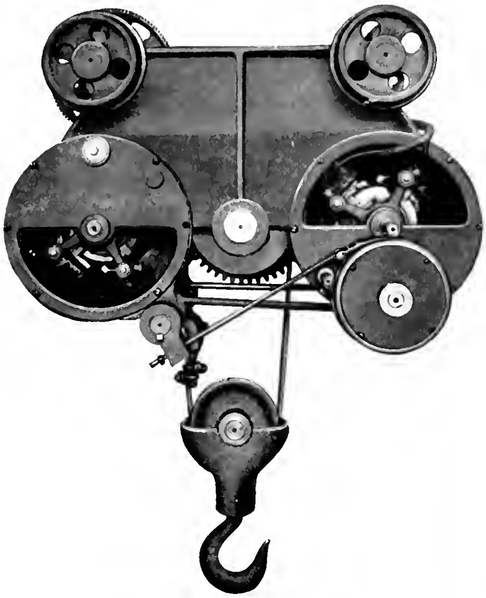
STEEL FRAME HOIST.

The illustration is of a newly designed hoist which is built in sizes 3, 5, 6 and 10 tons capacity by the Detroit Engineering Works, Detroit, Mich. The frame is of steel, cast in one piece, including the frames for the hoisting and propelling motors. Cast integral with this frame are also the boxes supporting the truck wheels. On the side of the hoist where the gears are placed, and where all the strains come, the web plate is cast as part of the frame and is of steel. This is on the side opposite to the motors. The plate on the side where the motors are located is cast separate and is removable, giving complete access to all parts of the motors. The pinions and their shaft are in one piece and the gears and pinions are all interchangeable.

The cast-iron drum is turned and grooved for plough-steel

cables and is supported at each end so that it cannot be pulled out of alignment, since there is no overhang pull on the drum.

The armatures of the hoisting and propelling motors are of the same size and are interchangeable, except in the 10-ton hoist. They are mounted on independent spiders, which also carry commutators and can be easily removed from their shafts.



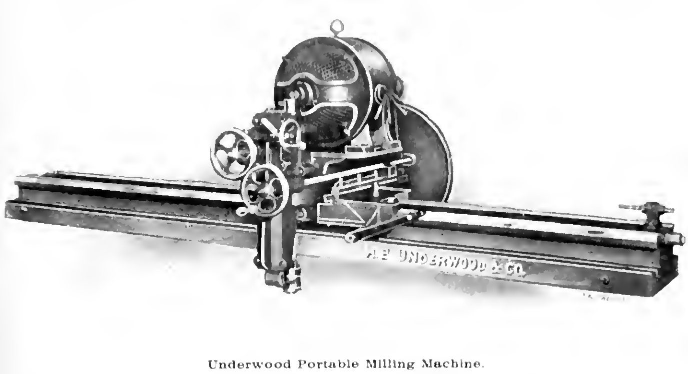
Detroit Engineering Works Hoist.

A simple type of automatic brake is employed, every part of which is accessible, and there are no solenoids or other electrical devices used in connection with the brake. Provision is made against dropping a load through carelessness, since it can be lowered only by rotating the motor.

Another feature of construction is the use of oilless bearings, which were adopted to avoid cutting out bearings through neglect to properly oil them. There are grease cups on the truck wheel bearings, but all others are run without the use of oil or grease. The controllers are of the rotary reversible type and can be mounted on the frame of the hoist or in a cab on the frame of the crane and be operated either by a pendent or an ordinary controller. These hoists are well adapted to be mounted on either single or double I-beams, which in many cases is a satisfactory arrangement and less expensive than the regular type of crane.

SPECIAL PORTABLE MILLING MACHINE.

This portable milling machine is an evolution from a temporary rig which was employed on special work by its builders, H. B. Underwood & Co., 1025 Hamilton St., Philadelphia,

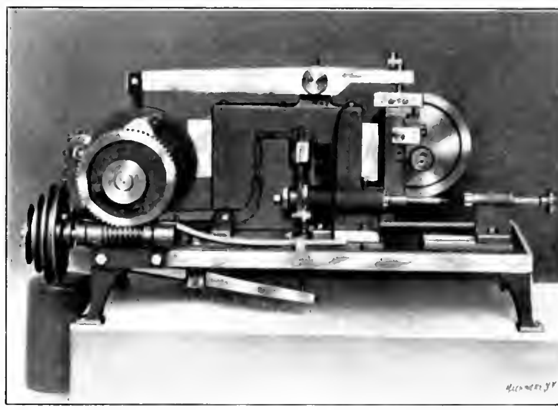


Underwood Portable Milling Machine.

Pa. The original idea has been elaborated on from time to time until it has become one of their regular line of special tools. It is designed for straight line work up to 8 feet in length, for milling a number of surfaces which are in line but on different planes. The machine is mounted on a sub-base allowing accurate adjustment by means of set screws which bear against taper spacing pieces, thus holding the two beds as securely as though they were in one piece. The sub-base has slots and projections for securing it to the work by clamps or bolts. On the base is mounted a carriage with its attached driving motor. The carriage has a travel of 8 feet with automatic feed, while the cross slide has a hand feed travel of 12 inches. The vertical spindle has an up and down adjustment of 10 inches and is bored to receive taper shank mills. The fact that the machine is motor driven allows it to be readily carried about to any place where work is required to be done. It will do work of a character impossible for regular machine tools to handle, and is particularly adapted to taking long cuts on partially or fully assembled machines.

AUTOMATIC MACHINE FOR CUTTING SMALL GEARS.

The Vandyck-Churchill Co., 8 Dey St., New York, is putting on the market a new small automatic gear-cutting machine built by the Standard Mfg. Co., Bridgeport, Conn. This machine is adapted to making small bevel gears, pinions, spur



Small Automatic Gear Cutter.

gears, etc., up to 4 inches in diameter, and by furnishing special cams can be used to cut irregular outlines. It will cut teeth in single blanks, or in stacks up to 2 inches long. The various motions of feeding the cutter, raising it out of the work, indexing the blank, returning the cutter to commence the next cut, and dropping it into its position, are all attended to by cams on a constantly running cam shaft which is driven by a worm and worm wheel from a three-speed pulley. This, in combination with other changes in the mechanism gives a series of nine different feeds. Two speeds are provided for the cutter spindle. The cutter works ninety per cent of the time, as it is raised clear of the work while returning, and the indexing, which is positive, is performed at this time. Both the work and cutter spindles have taper bearings with compensation for wear. Owing to the simplicity of its construction there is little chance for the machine to get out of order and it can be run at the highest desirable speed without noise or vibration.

MACHINE FOR MAKING PAPER TRANSPARENT.

A novel machine has been brought out by Chas. L. Crabb & Co., 21 Lincoln Place, Brooklyn, N. Y., which, in connection with what is really a new process, is intended to do away with the tracing and inking-in of original drawings in drafting-rooms and engineering departments of manufacturing plants and offices. The principle of the machine and process is to render drawings which have been made on white paper with lead pencil or ink permanently transparent so that blueprints may be taken from them. Paper thus treated is so

transparent that prints can be made from it in less time than from tracings, and it is entirely unnecessary to ink in a drawing, since pencil lines give sufficient contrast to make a clear print.

Fig. 1 is reproduced from a pencil drawing which was cut in two, one-half treated by this process, while the other half remained in its original state. The two pieces were placed side by side over a page of MACHINERY, and it will be noted from the engraving that the left-hand half, which is the treated portion, is so transparent that the printing underneath is easily read, while the right-hand part is entirely opaque.

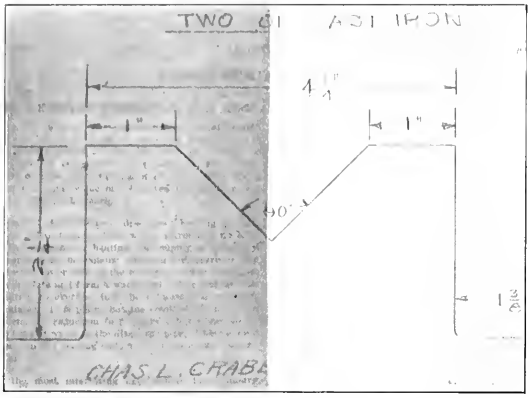


Fig. 1. The Left Half of Drawing has been made Transparent and the Characters of a Printed Page underneath are Plainly Visible.

The left-hand part appears darker than the other in the engraving, because after being treated the paper is slightly yellow, a color which reflects but few actinic rays and produces a dark photographic print. When photographs are to be treated, a tray, which forms a part of the machine and contains the solution to be used, is heated either by a Bunsen burner or an electrical resistance coil, as most convenient; and the sheet is fed into the machine and passed through this heated bath by the rotation of a crank. After leaving the bath the sheet passes between hot calender rolls which squeeze out the surplus liquid, giving the sheet a smooth and dry surface. The process requires less than a minute.

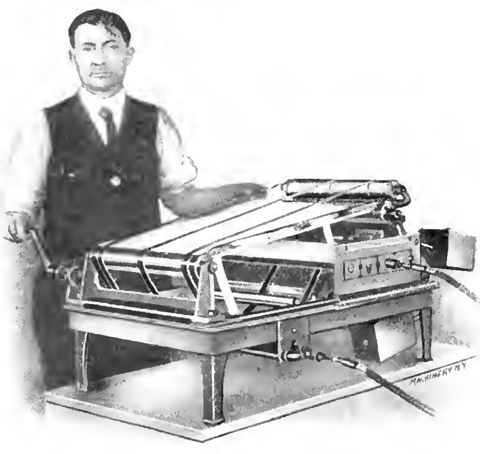


Fig. 2. The "Transparentizer" in Use

Drawings subjected to this treatment are not only transparent, but water and mildew proof, and the solution used is of such a character that the paper is not greasy or oily and will not stain blueprint paper during the process of printing, even when the printing is done in warm weather and by sunlight. An important question that might be raised in regard to this process is whether drawings can be easily corrected after the paper has been treated. We are informed that this is possible by first erasing the pencil lines and using a solution such as naphtha, to cut the coating given to the paper and restore the original surface of the paper. Pencil marks can be made upon it, after which the whole sheet is run through the machine again and the place where the correction was made is restored to its former transparent condition.

Illustrations 2 and 3 give an idea of the relative size of the machine. Drawings are carried through the bath and between the calender rolls by means of endless metal belts. It is said by the manufacturers that it is possible to "transparentize"

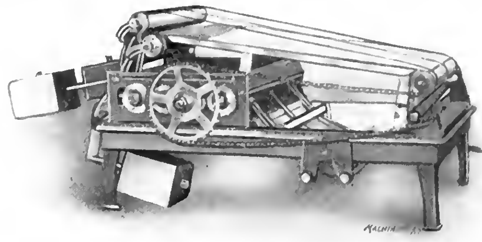


Fig. 3. Opposite Side of "Transparentizer."

drawings which have been made on heavy Bristol board. It is believed that the process will almost entirely do away with the making of tracings in offices where the machine is adopted, thus saving a large item of expense and giving entirely satisfactory blueprints. The machine is styled by the builders a "transparentizer."

TOOL HOLDER FOR LATHE AND PLANER WORK.

The Bown Machine Co., Ltd., of Battle Creek, Mich., make the improved lathe and planer tool holder shown in the accompanying halftone. As may be seen it takes a larger and longer cutter bar than do most of the holders of the same size, many of which take only a very short piece of tool steel, of which not more than half, perhaps, can be used. With this tool

Tool Holder for Bar Stock.

any desired length can be used. The tool-post screw is set down on the cutter bar, thus holding it very rigidly. The end of the blade may be ground for plain turning or side tool work, or formed to shape for thread cutting, etc. It may be extended forward so as to cut into a narrow space and will take a good-sized cut without chattering, owing to the large size of stock used.

* * *

An error was made in the article "The Machine Shops of the Pratt Institute" appearing in the April issue. In the list of tools mentioned as forming a part of the machine tool equipment it was stated that an Espen-Lucas boring machine was one of the tools, whereas this tool is a Lucas precision boring machine built by the Lucas Machine Tool Co., Cleveland, Ohio.

* * *

PERSONAL.

MR. A. A. SCHAEFER, formerly associated with the Standard Engineering Co., Ellwood City, Pa., in the capacity of general sales agent for New York City and surrounding territory, has severed his connection with that company, and is now connected with the Stoever Foundry & Mfg. Co., making his headquarters at the New York office, 95 Liberty Street.

GORHAM C. PARKER, formerly manager of the Superior Tap Co., Springfield, Vt., and later New England representative of the Pittsburg Tool Steel Wire Co., Monaca, Pa., has resigned the latter position to accept the position of sales-manager for the Jacobs Mfg. Co., Hartford, Conn.

MACHINERY.

June, 1906.

THE LIGHT MACHINE SHOP.

ITS PROPORTIONS AND EQUIPMENT.

EDWARD H. McCLINTOCK.

THE arrangement and proportioning of a manufacturing plant, and its equipment with necessary machinery, in such manner as to insure best working conditions with minimum floor space, is a subject demanding the closest attention of the prospective manufacturer. Plants are frequently erected which prove a constant detriment to economical production, and a continued source of annoyance both to superintendent and workman, due to improper departmental arrangement or to either too great or insufficient floor space. In connection with these latter subjects the writer has compiled various notes; certain of which, pertaining to the manufacture of light high-grade machinery, are submitted herewith.

The selection of the general location is the primary consideration, upon which various details have direct bearing. Steam motive power to-day compares favorably in cost with that of water, and has the advantage of being a constant force under nearly all conditions available throughout the entire year. If we assume then that the power is to be steam, the plant should be located near a personally-controlled water supply, sufficient, at least, to supply a full quota of condensing water, which should daily average not less than one-third the amount which is to pass through the condensers. That is to say, the water in the storage basin will, in warm weather, become too hot for condensing purposes if passed through the condensers more than three times per day. If the water be in sufficient quantity, and of proper quality for boiler feed, it is, of course, so much to the good.

In general, the plant should be located in a region productive of good mechanics, a neighborhood in which there are other factories, either existing or prospective. A machinist is seldom content to "settle down" in any town unless he believes it possible for him to secure other employment in the same vicinity, without being obliged to move his household should he lose his position which he is then holding. To continue, a low first cost may be obtained by locating near a base of supplies, a low rate of transportation of raw materials, power-house and foundry supplies by locating near the sea, and low freight rates by locating near a town containing several railroad lines. A site containing all the foregoing advantages would, of course, be almost purely ideal, but many are to be found which contain two or more of them. Other than the foregoing the main consideration is the cost of foundations. The common soils, other than ledge, are, in order of desirability, hard gravel (hard pan), confined dry sand, and clay, generally considered as capable of supporting 6,000, 4,000 and 2,000 pounds per square foot. All soils should, of course, be carefully tested before being finally built upon.

In order to predetermine the required area for the plant, the type of buildings must be decided upon. The one-story building with its saw-toothed roof is ideal for laying out departments in their consecutive order, as well as the ease with which these departments may be served by traveling cranes, trolleys, etc., but the high cost of land in the East is generally considered sufficient argument against its general adoption. The four-story building is, in this locality, generally conceded to be the most economical. The proper dimensions for buildings of this type, designed to insure good light as well as an economical layout of machinery, are from 50 to 75 feet wide with stories from 12 to 16 feet high respectively. If the buildings are to run north and south, as is generally considered the most desirable arrangement, 70 feet should, if possible, be allowed in the clear between buildings. If they are to run east and west, 90 feet should be allowed between them, and the buildings may be conveniently arranged like a letter U with the eastern side forming the base of the letter.

In the preliminary preparation of estimates of required floor space within the building lines above noted, the following notes have proven useful to the writer. The same are true for economical laying out of machine tools, which subject will later be further discussed.

Size.	Machine.		Greatest No. of Machines per 1,000 square feet.
12 to 20-inch	Engine lathes	Faced same way	20
12 to 20-inch	Engine lathes	Back to back	24
22 to 24-inch	Planers	Heads and tails	10
22 to 24-inch	Planers	Faced same way	9
28 to 30-inch	Planers	Faced same way	5
14-inch	Multi-spindle drills		40
16 to 20-inch	Upright drills		36
26 to 30-inch	Upright drills		12
	Small milling machines. (Similar to No. 4½ Brainard)		36
	Milling machines (Similar to No. 3 Brainard and No. 1 and No. 2 B. & S.)		20
	Automatic screw machines		20
	Hand screw machines		15
	Plain and universal grinders		15
	Polishing machines		24

The above areas are exclusive of main passageways, and if it is decided to run a 6, 8 or 10-foot passage the entire length of the building, this area must be added, also the following areas for each 100 horsepower of plant, which are the average areas in various factories examined by the writer:

Offices	350 square feet.
Storage of office supplies	100 square feet.
Shipping and boxing	450 square feet.
Storage of tools	650 square feet.
Inspecting	1,000 square feet.
Drafting	400 square feet.
Pattern lumber storage	75 square feet.
Bar stock storage	700 square feet.
Storage of finished parts	3,000 square feet.
Storage of patterns	220 square feet.

The areas required for setting up and storage of assembled machines will, of course, vary greatly with each individual instance, and no approximate figure can be given. The same must be determined for each individual case.

A "clearance" department capable of caring for at least one-half day's work should be left vacant on each floor. This space to be in excess of any probable growth in adjacent departments.

Roughly: A manufacturing machinist on light work requires 100 square feet floor area average. For example, he will run two milling machines, two engine lathes, but only one planer. A toolmaker or experimental man requires 200 square feet; a molder on light work, 200 square feet, and one on heavy work, 400 square feet.

From the foregoing a close approximation of the amount of land and size of manufacturing buildings may be obtained, and a preliminary layout started after the manner of planning the manufacturing proposition and erecting the buildings around it.

Laying Out Machine Tools.

In the manufacture of light parts, where a proper clearance department is maintained, the storage space near the machine necessary for work in hand is small, and as an operator frequently runs two and even three machines, the nearer these machines are set together, consistent with ease in getting around them, the better it is for economical production. To

this end the writer has adopted the following rules for setting up machine tools. While, of course, exceptional cases have arisen, in general he has found them satisfactory.

	Center to Center.
10 to 20-inch engine lathes set face to face and offset 2 feet or more	4 feet 6 inches.
10 to 20-inch engine lathes set face to face and not offset	5 feet 6 inches.
10 to 20-inch engine lathes set back to back	3 feet 0 inches.
10 to 20-inch engine lathes set face to back	5 feet 0 inches.

Above 34-inch swing the center distance must be determined by the nature of the work usually in hand, and whether or not the machine is to be served by crane, trolley, etc.

Least distance from end of one lathe to stud of adjacent lathe in same line	6 feet 0 inches.
Least width of cross passageways in clear	2 feet 6 inches.
17 to 24-inch planers set heads and tails, machines in pair, center to center	6 feet 6 inches.
17 to 24-inch planers set heads and tails, machine of one pair to machine of next	5 feet 0 inches.
17 to 24-inch planers set heads and tails, offset between housings	2 feet 0 inches.
17 to 24-inch planers set faced same way, center to center	6 feet 6 inches.
36 to 50-inch planers set heads and tails, machines in pair, center to center	8 feet 6 inches.
36 to 50-inch planers set heads and tails, machine of one pair to machine of next pair	7 feet 0 inches.
36 to 50-inch planers set heads and tails, offset between housings	2 feet 0 inches.
36 to 50-inch planers set faced same way	8 feet 6 inches.

Sensitive and light upright drills up to 24-inch should be set in parallel rows face to face and back to back. Distance in the clear between rows facing each other, 4 feet 6 inches. The writer's preferred method of setting these tools is to place a row of lighter drills opposite a row of slightly heavier, and to work each in conjunction with multi-spindle drills on the end.

Each drill, having a table, should be set so that it may swing entirely out of the way of the platen, and clear the table of its neighbor when the latter is in its central position. Upright drills 24-inch and upwards, if not served by crane, should be set in parallel rows and all faced the same way, clearances between the rows to be from five to seven feet, depending on the size of the work usually in hand. Large drills served by crane should be set face to face with eight feet in the clear, as before, all drills being set so that tables will clear as noted above.

Milling machines, plain and universal grinders set face to face should be set 5 feet 0 inches center to center of platens. Those machines coming back to back must be offset sidewise 8 inches to allow room to drift out their arbors. Machines set all facing the same way should have a minimum clearance between rows of 2 feet 6 inches. In general, all machines should be set to leave one foot clearance between adjacent platens when same are in extreme positions.

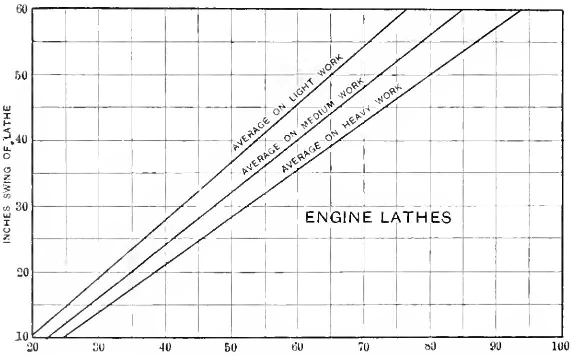


Fig. 1. Power Required to Drive Engine Lathes.

Automatic screw machines should be set back to back and staggered so that stock for one machine will feed in between the back of machine in same row, and the back of the machine in the row behind it.

Distance between centers, face to face	9 feet 0 inches.
Distance between centers, back to back	4 feet 6 inches.
Angle of Pratt & Whitney machines with line shaft	12 degrees.
Angle of Browne and Sharpe machines with line shaft	12 degrees.
Angle of Cleveland machines with line shaft	16 degrees.

Hand screw machines should be set in rows with cross passageways running diagonally across the buildings, but machines themselves parallel with the line shaft, each machine being set the other way around from the machine next in line longitudinally with it, and with sufficient endwise clearance to allow a 16 or 20-foot length of stock to be inserted.

Polishing machines should be set in rows lengthwise of building, faced same way. Distance between centers of rows, 9 feet 0 inches; sidewise clearance between machines, 3 feet 0 inches.

In the drop forge shop:

Trimming presses should be set as near as possible to the hammer in conjunction with which they are to be used, and to the left of the hammer as you face it. Room only should be allowed to remove the driving pulley. Least practical distance between the trimming press and the hammer in next adjacent pair, 2 feet 0 inches in the clear.

Least practical distance in the clear between the blast forge and the hammer, if forge be water jacketed, 6 feet 6 inches in the clear. If forge be without water jacket, 8 feet 6 inches in the clear. Center of blast forge should be offset at least 2 feet to the left of the hammer as you face the hammer, so that the heat will not come directly on the blacksmith's back.

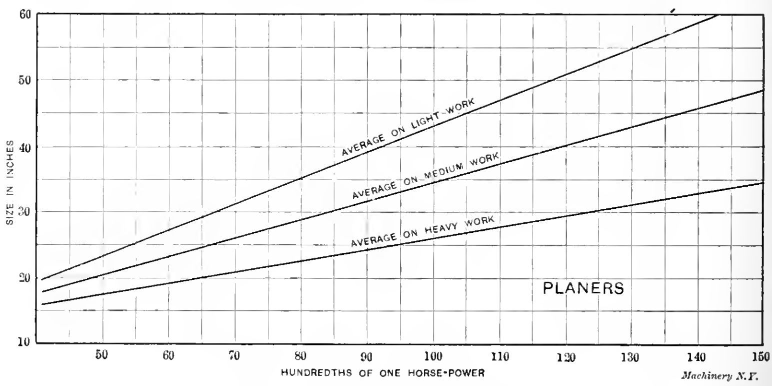


Fig. 2. Power Required to Drive Planers.

If a helve hammer be set in line with the drops, for breaking down or drawing out, the anvil block should be set 3 feet in front of the base line of the drop hammers. Least distance back of an anvil to safely swing a sledge, 7 feet 6 inches in the clear. Of course, all the foregoing rules will be varied slightly to accommodate belt space, which is the main trouble in economizing floor space.

Before an estimate can be placed on the space required for the power plant, an estimate of the power required by the machine tools, etc., must, of course, be made. In connection with this subject the type of drive (electric group, electric individual, or belt) must first be decided upon. For light machine tools, that is to say, machine tools requiring less than 2 horse power average, the individual drive may at once be eliminated, there being no economy in this type as far as power is concerned, and a large first cost is necessitated. The average efficiency of these light motors at full load is about as follows:

1/8 horse power	28 per cent.
1/4 horse power	43 per cent.
1/2 horse power	56 per cent.
3/4 horse power	58 per cent.
1 horse power	70 per cent.
2 horse power	75 per cent.

The efficiency, of course, drops off as the load decreases. In an individual drive the motor must be not only sufficiently large to drive the machine at its maximum load, but also to

overcome the inertia of starting, this, of course, being overcome in group drives by the momentum of shafting and elements of one machine at high power balancing another at a lower power.

The following few comparisons of actual average horse power used and motors actually installed as individual drives for similar machines are made from electrical tests of power of light machine tools, and compiled from notes taken in various shops of motors actually used for individual drives.

Size and Machine.	Average H. P. Required at Machine.	H. P. Motor Required for Individual Drive.	App. Eff Motor at Required H.P.	Average H P. required at Motor.	Average H. P. Lost in Motor.
16-inch engine lathe	.30	2	55%	.54	.24
30 x 30 x 8 planer ...	.87	5	60%	1.45	.58
4-spindle sensitive drill	.47	3	55%	.85	.38
20-inch upright drill	.32	2	55%	.58	.26
No. 2 milling machine	.25	2	50%	.50	.25
2-inch automatic screw machine...	.75	4	65%	1.16	.41
2-inch hand screw machine	.45	3	55%	.82	.37
No. 11 Plain grinder	.75	4	65%	1.16	.41
18-inch shaper	.45	3	55%	.82	.37

Opposed to the above, the per cent friction to total load of line and countershafting for various manufacturing departments in which the machine tools are laid out, as before described, is on an average as follows:

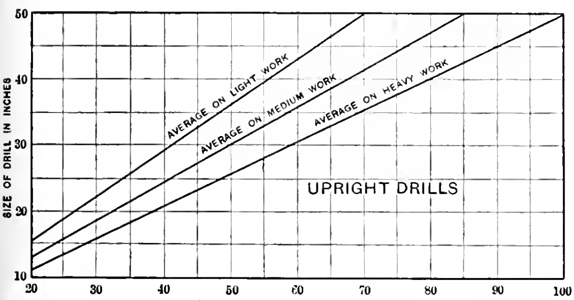


Fig. 3. Power Required to Drive Upright Drills.

Lathe department	30 per cent
Planer department..............................	30 per cent
Drill department (belted direct from line shaft)..	20 per cent
Drill department (belted with countershafts).....	30 per cent
Milling department	25 per cent
Screw machine department.......................	30 per cent
Grinding department	25 per cent
Cutting-off department	35 per cent

In the average machine shop running at full capacity, generally at least 75 per cent of the total machines are running at the same time, and if driven in groups a machine taking a heavy cut at maximum power will be generally balanced by a machine taking a light cut at minimum power. To quote from MACHINERY'S data sheet of September, 1902: "For group driving, determine average horse power for each tool, add these together, and use a motor with a capacity of from 40 to 70 per cent of the total thus obtained." This is excellent practice if one can be sure that no more machine tools are to be added to the motor load. The writer's method is to assume that 75 per cent of the machine tools installed are to be running at one time, and to provide a motor equal to their combined average horse power. This would mean only a 30 per cent overload on the motor if the entire group were temporarily running at one time.

To demonstrate, let us assume a department of 80 engine lathes averaging 16-inch swing. From above table the average horse power used by each machine alone is .30, or 24 H. P. for the department, if all machines were in operation. Assuming 75 per cent of these machines to be in operation at one time, the two propositions, electric individual and electric group drive, would stand roughly as follows:

Individual drive:

H.P. required to run 60 motors at .54 H.P............	32.4
H.P. transmitted to 60 lathes at .30 H.P.............	18.0
H.P. lost in motors at .24 H.P.......................	14.4

Group drive:

H.P. transmitted to 80 lathes at .30 H.P..............	24.00
Department friction line and countershafts to *total load* 30%	
Total H.P. line shaft, countershafts and 80 lathes....	34.28
H.P. friction line shaft and 80 countershafts..........	10.28
H.P. transmitted to 60 lathes at .30 H.P............	18.00
H.P. transmitted to 60 lathes, line shaft and 80 countershafts	28.28
Efficiency 30 H.P. motor at full load.......... 90%	
H.P. required to run motor	31.42
H.P. lost in motor	3.15
H.P. total lost in motor and shafting.................	13.43

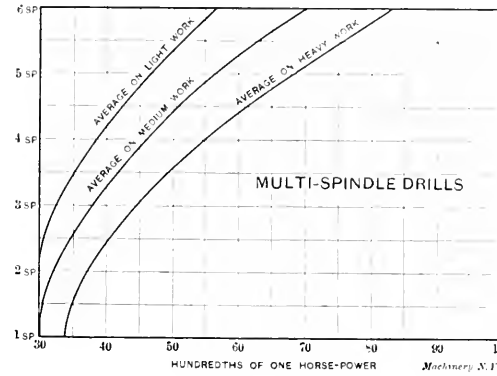


Fig. 4. Power Required to Drive Multiple-spindle Drills.

Summary:

First cost 80 2-H.P. motors at $150..............	$12,000.00
Cost installing 80 motors at $5..................	400.00
Total cost individual drives.................	$12,400.00
First cost 30 H.P. motor........................	$750.00
Cost of installing 30-H.P. motor	12.00
Cost 1,300 feet of belting at 20 cents............	260.00
Cost 10,000 board feet Southern pine stringers at $45	450.00
Estimated cost shafting, hangers and couplings.	500.00
80 countershafts at $18..........................	1,440.00
Estimated cost erecting.........................	500.00
Cost of main belt..............................	18.00
	$3,930.00

H.P. saved in group over individual drive.	1.00
Percentage saving in total power.........	3½%
Saved per year at $30 per H.P............	$30.00

The accompanying diagrams of required horse power of light machine tools are used by the writer for estimates of power in all places where no accurate electrical tests of power

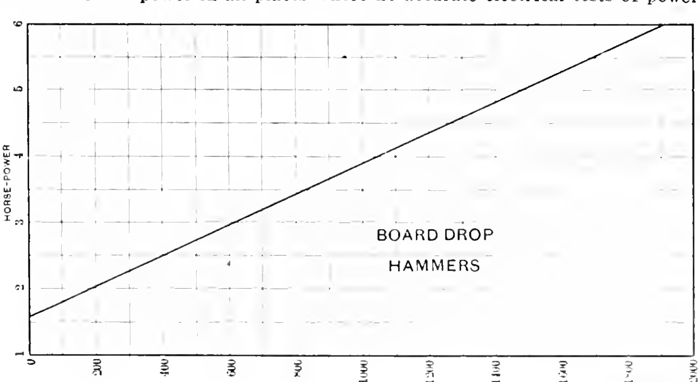


Fig. 5. Power Required for Board Drop Hammer.

under existing requirements of a particular line of manufacture are to be made. The notes from which these diagrams are made were compiled from electrical tests made in several factories manufacturing light machinery. In conjunction with these diagrams, various machine tools require an average horse power as follows:

Speed lathes	.10 H.P.
10-inch to 18-inch crank planers	.10 to .50 H.P.
Grindstones	.10 H.P.
Cutter and reamer grinders	.30 H.P.
Gardner grinders	.50 H.P.
Polishing machines	.80 to 1.25 H.P.
Radial drills	.75 to 1.25 H.P.
1 to 3-inch cutting-off machines	.15 to .25 H.P.
1 to 3-inch automatic screw machines	.60 to .80 H.P.
1 to 3-inch hand screw machines	.10 to .50 H.P.
20 to 30-inch boring lathes	.35 to .40 H.P.
24-inch wood panel planers	3.75 H.P.
24-inch wood surface planers	2.25 H.P.
14 to 18-inch wood lathes	.30 to .40 H.P.
36-inch gap lathes	1.30 H.P.
Band saws	.90 H.P.
8-inch to 12-inch circular saws	1.00 to 1.25 H.P.
Sand paper wheels	.75 H.P.
17-inch to 20-inch shapers	.40 to .50 H.P.

entrance, all the out-of-door lighting, and incandescent lamps in locker and wash rooms, passageways, etc. One 16-candle power light placed 7 feet from the door will satisfactorily light 250 square feet in a storehouse, and from 100 to 110 square feet general lighting for the factory proper.

The writer has purposely omitted the subject of department arrangement, believing that subject to be superfluous in view of the numerous articles lately written on the direct passage of production through various shops without retrograde movements, all of which articles tell the same story, with minor variations. Powerhouse design and equipment is also a subject too broad to come under the head of this article. The writer's aim has been to supply such notes on areas and power as might be of interest in predetermining the same up to the powerhouse doors.

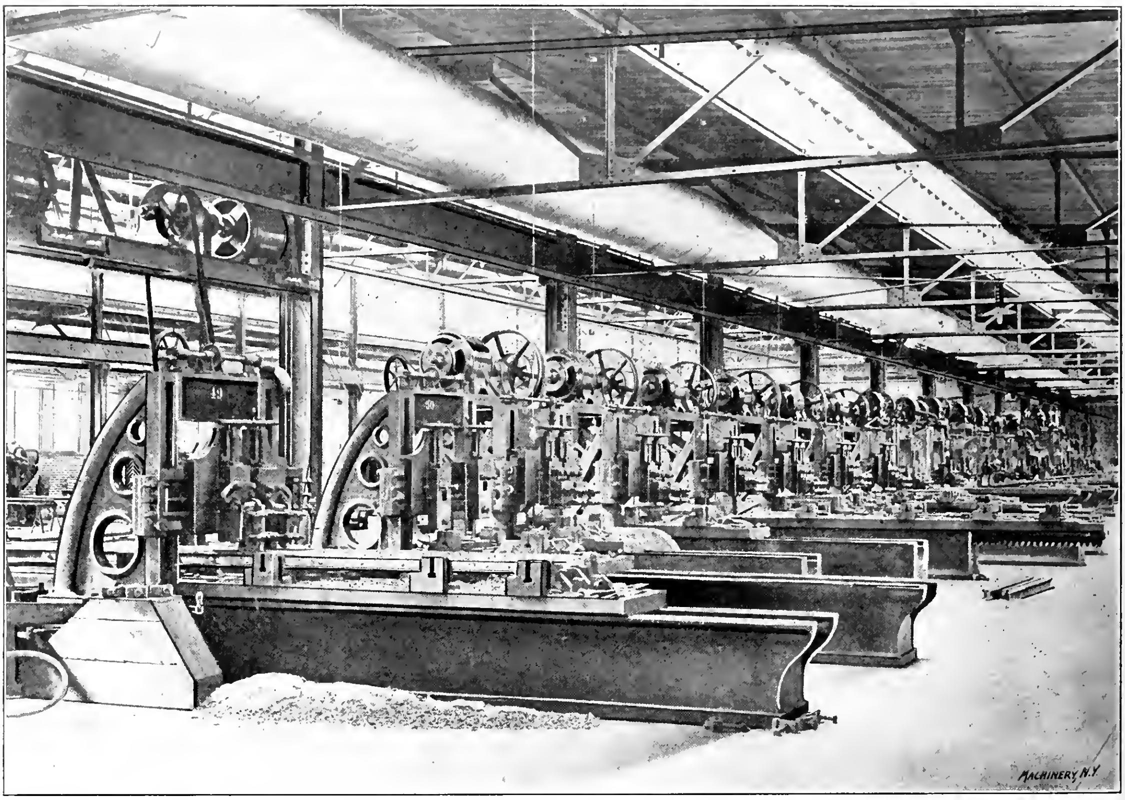


Fig. 1. A Row of Motor-driven Frog and Switch Planers.

After figuring the required horse power of the machine tools back to and including the driving motor, the loss in the electric mains back to the power plant must be figured. Formulas for this are, of course, to be had in every handbook, and will not be of interest here. If the factory is to be belt driven throughout, the friction load will vary from 40 to 50 per cent, depending on the location of the power plant, the ease of the belting scheme, etc.

The power required for lighting must, of course, be figured accurately for each particular layout; incandescents figured for $3\frac{1}{2}$ watts per candle power, and arcs at 10 amperes 50 volts. In the preliminary estimate the lighting load may be assumed as between 55 and 60 per cent of the manufacturing load. The circuits should be divided into three classes—machine tool circuits, consisting of one 16-candle power lamp for each machine tool, which should be turned on by the engineer as soon as light begins to fail in the factory; day circuits, which are on throughout the entire day, consisting of one 32-candle power lamp for each office desk, drafting board, etc., and 16-candle power lamps in the storehouse and isolated parts of the factory; and general lighting circuits, which should be turned on five minutes before time of shutting down, consisting of arc lights at each elevator, stairway or main

MODERN METHODS IN THE MANUFACTURE OF RAILROAD FROGS.

The Louisville & Nashville Railway Company recently placed a contract for furnishing its entire supply of railway frogs for the coming year with a single concern, the Weir Frog Company, which possesses one of the best equipped shops for this class of work in the country. They are located at Norwood, Ohio, a suburb of Cincinnati.

The main shop is a single story brick structure 720 feet long and 125 feet wide, with a floor space of approximately 89,000 square feet. The main aisle has a span of 61 feet and the two side bays each a span of 31 feet. The roof is supported on structural steel columns and trusses. The shops are roomy and well lighted from both skylights and side windows. The windows in the side walls set 6 feet above the floor, and there is also a line of side windows set above the roof of either side bay.

The two-story buildings adjacent to the main shop structure at the south end are identical in size, 40 x 60 feet, and are used, one for general offices and drafting room, the other for service rooms fitted with men's lockers, lavatories, etc., and pattern shop and storage on the second floor. Each of these

buildings is connected with the shop by short covered passage ways.

The erecting and main machine floor is 125 feet by 310 feet, served over its entire length by two electric cranes, one of which is used largely in loading and unloading freight cars, brought into the north end of the shop building on a switching track capable of holding twelve cars, and so built that the car floors come flush with the main floor of the shop. On the main machine floor are the planers, straightening machines, and special tools of various kinds used in handling the rails for the manufacture of railway frogs. The second crane supplies the erecting floor and machines with material from the stock department which is located just beyond the erecting floor. In this department, a space of 60 x 380 feet enclosed by a fence, is kept all material received in the shops. The forge department, in the south bay, is equipped with forging machines, presses, hammers, heating furnaces, etc. In the north bay and opposite the forge department, the special tools for bending, curving and drilling rails are located.

The power plant consists of a 500-H.P. automatic compound engine, direct coupled to a 300-K.W. Allis-Chalmers direct-current generator, 220 volts. Every machine tool in the shop, with the exception of a few small machines taking power from two lines of motor-driven shafting, is driven by a separate Allis-Chalmers type "N" direct-current motor. A steam-driven air compressor furnishes 500 cubic feet of free air per minute at 90 pounds pressure, for the operation of pneumatic reamers, drills and riveters, and also for the operation of pumps.

The boiler room is equipped with two 250-H.P. water tube boilers fitted with mechanical stokers. An artesian well, 320 feet deep, supplies all water used on the premises. It is pumped by compressed-air pumps to a storage tank 60 feet above ground, with 20,000 gallons' capacity. Water for the boilers is softened, then filtered and heated in an exhaust steam heater. The floors of the filter and boiler room are ten feet below the level of the engine room floor and eight feet below the ground level. The coal is received in hopper cars and dumped directly to the boiler room floor. The floors of the erecting and main machine shop are of concrete. The heating system utilizes exhaust steam from the engines for heating coils of pipes over which air is blown and distributed throughout the buildings.

In Fig. 1 is a view of the rather impressive row of motor-driven planers at this plant, and in Fig. 2 a general view of the erecting floor, showing the light, open construction, free from the maze of line shafting, belts and pulleys, which would go far to destroy the excellent lighting effects.

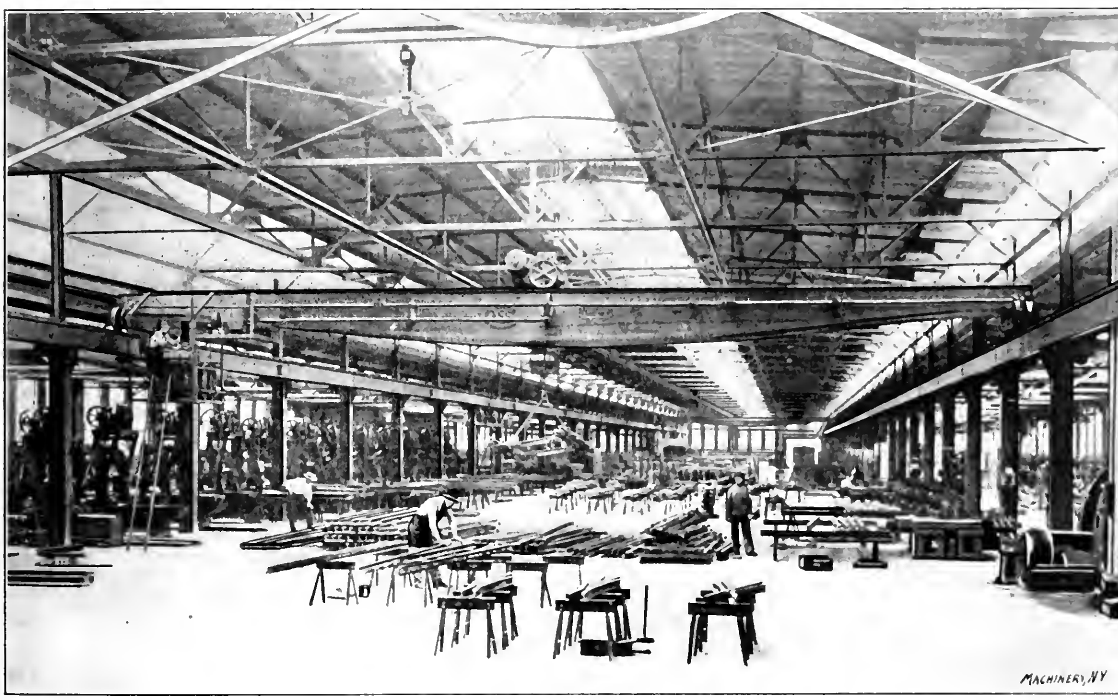


Fig. 2. Assembling Floor of the Weir Frog Company

* * *

TURBINE TROUBLES.

The most serious trouble experienced with the Parsons turbine has been the tearing out of more or less of the blading upon occasions when the rotor and stator came into contact through some accident, or otherwise. This type of turbine has usually been constructed with the blades unsupported at their outer ends; and consequently, when the stationary or moving vanes come into contact, or even if the moving vanes rub against the outer casing itself, it is inevitable that some of them will be torn out, and these in turn injure other blades.

The main cause for such trouble has been the distortion of the casing of the turbine, usually due, either to unequal expansion in the casing itself or in the piping leading to and from the turbine. Some of the earlier turbines had ribs underneath, forming a part of the supporting frame, which did not heat up as rapidly as the upper half of the shell, and produced distortion. The obvious remedy, which has been followed, was to abandon this construction and make the shell as symmetrical as possible. Also, the remedy for strains due to unequal expansion in the piping is the same as has been applied in steam-engine practice, namely, the introduction of corrugated expansion joints.

Still another cause for distortion is the pull—or more properly, the pressure—upon the casing due to the vacuum in the condenser. This amounts to some 13 or 14 pounds per square inch and when applied to the large area of the opening leading to the condenser produces a heavy stress within the casing. An ingenious plan for overcoming this has been adopted in Europe and to some extent in this country. It consists in placing the condenser under the turbine and suspending it from the turbine by bolting it solidly to the casing, while the turbine itself is supported on an independent foundation. The weight of the condenser is then taken by a flexible foundation consisting of some type of springs. This not only relieves the turbine of any stress due to the weight of the condenser, but prevents any possible distortion due to the "pull" of the vacuum.

COLLAPSING PRESSURES OF BESSEMER STEEL LAP-WELDED TUBES.

A series of very elaborate experiments has been carried on at the McKeesport works of the National Tube Co. to determine the behavior of modern wrought tubes when subjected to fluid collapsing pressure. The experiments were conducted on an extensive scale under the direction of Prof. Reid T. Stewart, Allegheny, Pa., and required for their completion the time of from one to six men during a period of four years. A carefully-prepared and very full account of these experiments formed the subject of a paper by Prof. Stewart before the Chattanooga meeting of the American Society of Mechanical Engineers. The completeness of the paper may be judged from the fact that it contained 87 pages and 58 diagrams, tables and illustrations.

Preparatory to entering upon the research, all existing published formulas that could be found for collapsing pressures were collected, most of which appeared to be based upon Fairbairn's classical experiments made more than half a century ago upon tubes wholly unlike the modern product. Without exception these formulas gave results differing widely from the pressures observed during these tests. As an illustration of this, the very first tube tested failed under a pressure that exceeded by about 300 per cent that calculated by Fairbairn's formula.

Two series of tests were conducted. The first was on tubes that were 8⅝ inches outside diameter, for all the different commercial thicknesses of wall, and in lengths of 2½, 5, 10, 15 and 20 feet between transverse joints tending to hold the tube to a circular form. The chief purpose of this series of tests was to furnish data for determining which of the existing formulas, if any, were applicable to modern lap-welded steel tubes, especially when used in comparatively long lengths, such as well casing, boiler tubes and long plain flues.

The second series was made on single lengths of 20 feet between end connections tending to hold the tube to a circular form. Seven sizes, from 3 to 10 inches outside diameter, and in all the commercial thicknesses obtainable, have been tested to date. The chief purpose of these tests was to obtain, for commercial tubes, the manner in which the collapsing pressure of a tube is related to both the diameter and thickness of wall.

The principal conclusions to be drawn from the results of the research may be briefly stated as follows:

The length of tube, between transverse joints tending to hold it to a circular form, has no practical influence upon the collapsing pressure of a commercial lap-welded steel tube so long as this length is not less than about six diameters of tube.

The formulas, as based upon the present research, for the collapsing pressure of modern lap-welded Bessemer steel tubes, are as follows:

$$P = 1{,}000\left(1 - \sqrt{1 - 1{,}600\frac{t^2}{d^2}}\right) \qquad \text{(A)}$$

$$P = 86{,}670\frac{t}{d} - 1{,}386 \qquad \text{(B)}$$

Where P = collapsing pressure, pounds per square inch.
d = outside diameter of tube in inches.
t = thickness of wall in inches.

Formula A is for values of P less than 581 pounds, or for values of $\frac{t}{d}$ less than 0.023, while formula B is for values greater than these.

These formulas, while strictly correct for tubes that are 20 feet in length between transverse joints tending to hold them to a circular form, are, at the same time, substantially correct for all lengths greater than about six diameters. They have been tested for seven diameters, ranging from 3 to 10 inches, in all obtainable commercial thicknesses of wall, and are known to be correct for this range.

The apparent fiber stress under which the different tubes failed varied from about 7,000 pounds for the relatively thinnest to 35,000 pounds per square inch for the relatively thickest walls. Since the average yield point of the material was 37,000 and the tensile strength 58,000 pounds per square inch, it would appear that the strength of a tube subjected to a fluid collapsing pressure is not dependent alone upon either the elastic limit nor ultimate strength of the material constituting it.

For the convenience of those who wish to apply these formulas, the charts reproduced on the next page were prepared.

The first chart, Fig. 1, shows the probable collapsing pressures for lengths greater than six diameters of National Tube Co.'s Bessemer steel lap-welded tubes, plotted to thickness of wall.

The second chart, Fig. 2, is for obtaining probable collapsing pressures from values of thickness ÷ diameter (t/d), for lengths greater than six diameters.

While planning this research it was assumed that the resistance offered by a tube to an external fluid pressure would depend upon the following five things, namely:

1. The diameter of the tube.
2. The length of tube between transverse joints or end connections tending to hold it to a circular form.
3. The thickness of the wall.
4. The deviation of the tube from perfect roundness.
5. The physical properties of the material of which the tube is made.

Of these five things that may vary it was thought that, for the preliminary experiments, at least, Nos. 4 and 5 would be practically constant; No. 4, because the tubes being all made by the same process, would probably run fairly uniform as to deviation from roundness, and No. 5, because the material in this case being Bessemer tube steel, is known to run fairly uniform in its physical properties. The physical tests would, of course, serve as a check upon this latter.

The only variation, then, to be expected in Nos. 4 and 5 would be that due to the inability of the manufacturer to turn out a uniform product. It is recognized here that the physical properties of rolled steel depend in some measure, other things being equal, upon the thickness of the plate; or, in this case, upon the thickness of the wall of the tube. It is clear that any variation would be a function of the thickness, and would consequently be taken care of in an empirical formula by the quantity representing the thickness.

The influence of length of tube between transverse joints, or end connections tending to hold it to a circular form, upon the collapsing pressure, appeared to be the most uncertain of all the variables entering the problem. It was therefore decided, first of all, to determine the precise nature of this influence.

The apparatus in which the tubes were subjected to an external fluid pressure was designed and built for this research and comprised the following main features:

1. A test cylinder with one head removable for the reception of the tube to be tested, this cylinder being provided with means for creating an hydraulic pressure within, thus subjecting the tube under test to a fluid-collapsing pressure.
2. A low-pressure water supply of large volume to rapidly fill the space within the test cylinder not occupied by the tube under test.
3. A variable high-pressure water supply furnished by an hydraulic-pressure pump, the purpose of which was to create a fluid pressure within the test cylinder, the tube under test by this means being subjected to a gradually increasing fluid-collapsing pressure.
4. A set of pressure gages, having a large range in capacity, connected so that they could be used either singly for indicating the fluid pressure within the test cylinder or in combination for comparison.
5. A vent pipe leading from the interior of the tube under test through the head of the test cylinder to the atmosphere, in order to maintain constantly an atmospheric pressure within the tube being tested.
6. An air vent connecting with the highest point of the interior of the test cylinder, in order to thoroughly free from air the interior of the test cylinder, while being filled with water, after the insertion of a tube to be tested.

Test cylinders of two different diameters were employed, one 16 inches and one 8 inches in diameter. The former was originally made up in three sections having a total length of

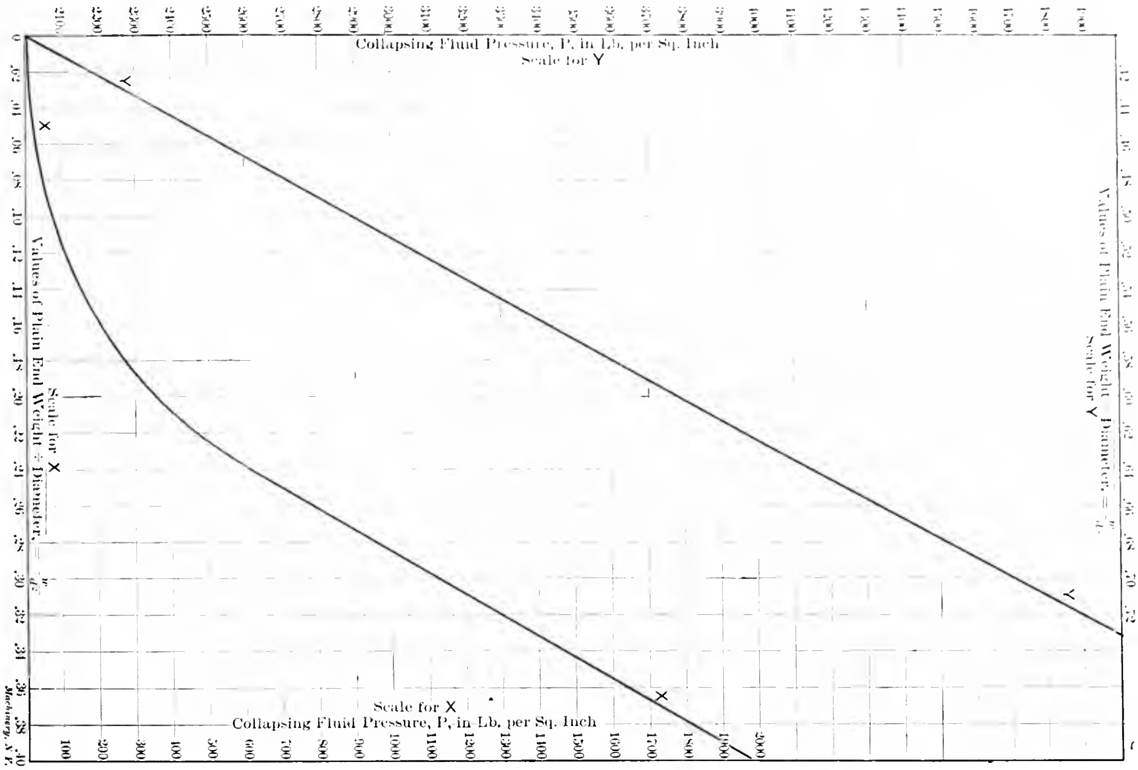


Fig. 1. Chart showing Collapsing Pressures for Lengths Greater than six Diameters Plotted

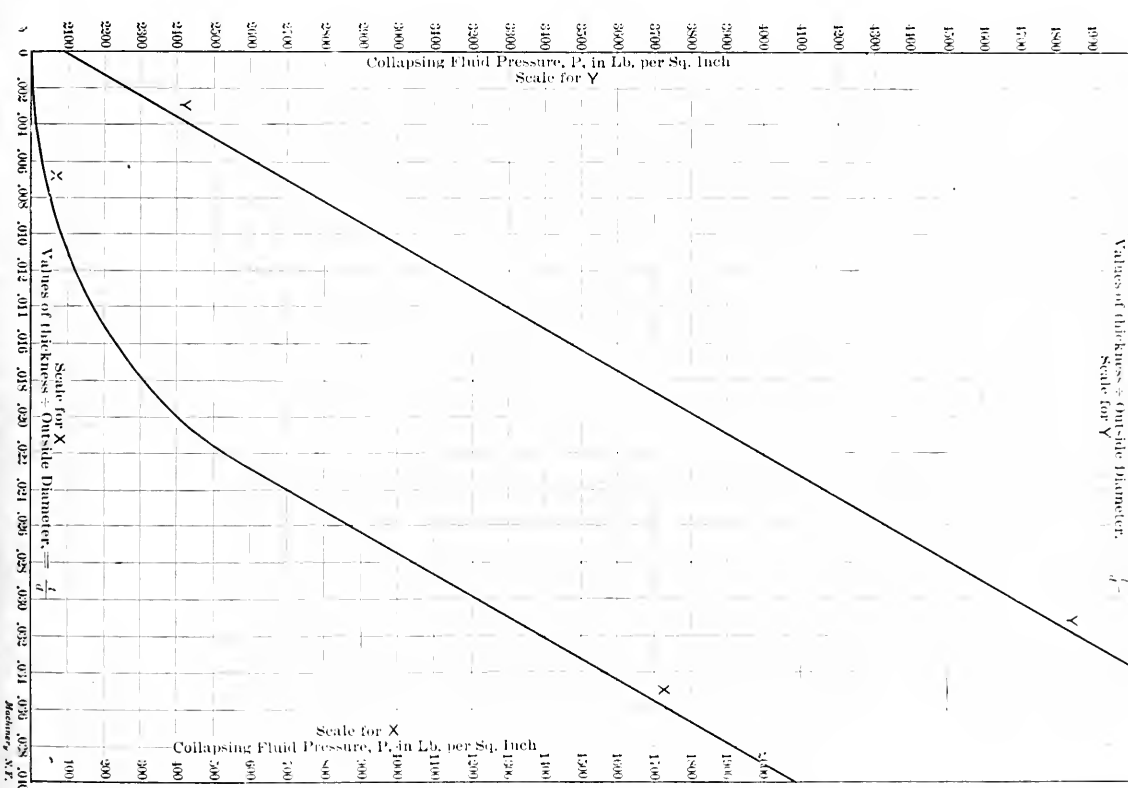


Fig. 2. Chart for obtaining Collapsing Pressures from Values of Thickness ÷ Diameter for Lengths

45 feet, the intention being to have it long enough to accommodate a string of well casing consisting of either two full lengths of 20 feet each, including three couplings, or one full length of 20 feet, with a half length coupled to each of its ends. It was soon discovered that the behavior of a tube in collapse was such that precisely the same results could be had from a single 20-foot length as from either of the above arrangements. Because of this the cylinder was shortened at the first opportunity, by the removal of the intermediate section, to a length of about 30 feet.

The 8-inch cylinder was for testing 3 and 4-inch tubes and was 20 feet long. It was arranged somewhat differently from

the 16-inch cylinder, but embodied the same principles and the 16-inch cylinder, Fig. 3, will be the only one illustrated herewith.

The rear end of the 16-inch test cylinder was connected, as shown in Fig. 3, to the low-pressure water supply of the works for the purpose of rapidly filling it. An air vent was provided at the top of the left-hand head.

The pressure within the test cylinder was created by means of a hydraulic-pressure pump capable of working against a fluid pressure up to 3,000 pounds per square inch. Ordinarily this pump was operated, upon entering the region of expected collapse, so as to increase the fluid pressure at a rate of from about 2 to 10 pounds per second, depending upon the gage used. At these rates of increase of pressure the conditions were favorable for the making of an exact determination of the fluid pressure under which the tube failed.

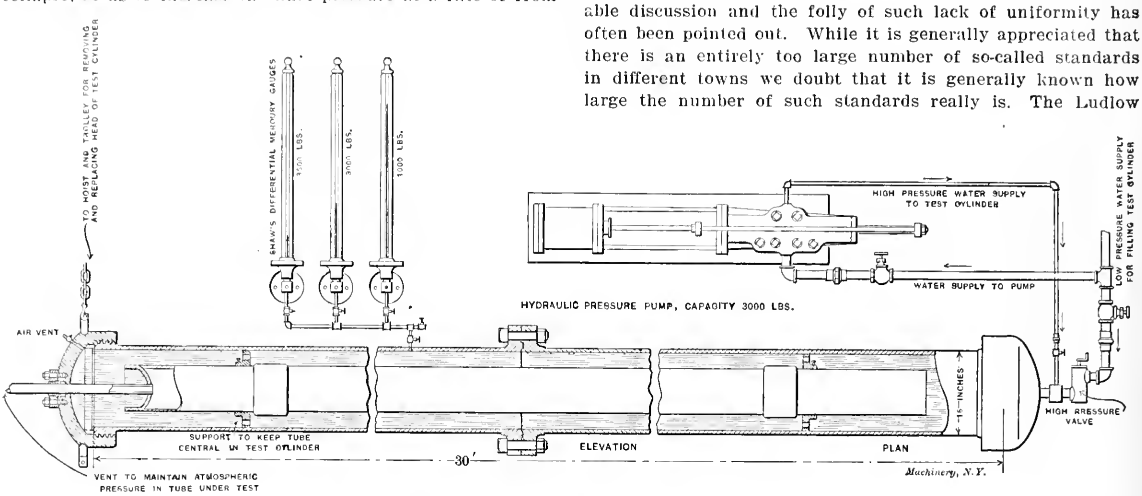


Fig. 3. Arrangement of Apparatus for Finding the Collapsing Pressure of Tubes.

The gages used for indicating the pressure at instant of collapse were three Shaw differential-piston mercury gages, having capacities of 1,000, 3,000 and 8,500 pounds per square inch. They were connected in the manner shown in Fig. 3. so that, by opening or closing suitable valves, any one or more of them could be connected to the test cylinder for the purpose of indicating the pressure therein.

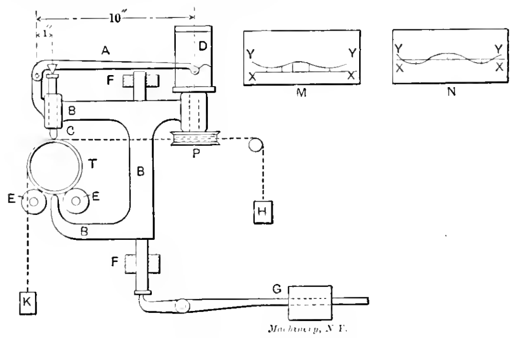


Fig. 4. Instrument for Measuring Out-of-roundness of Tubes.

Since it was anticipated that the out-of-roundness of the tube under test would exert a controlling influence on its behavior, it was thought best to devise a piece of apparatus to indicate this deviation from perfect roundness with great accuracy. A number of schemes for accomplishing this was worked out, one of which is illustrated in Fig. 4.

The tube, while being calipered, is rotated on supporting guide wheels, *E E*, by means of the guides *F F* and the counterbalancing lever and weight *G*. The lower calipering point is constantly kept in contact with the tube while it is being made to rotate. Any variation in the vertical diameter of tube is indicated by the motion of the upper calipering point *C*: which variation is magnified ten-fold and recorded on the drum *D* by means of the pencil mechanism *A*.

The recording drum *D* and the tube *T* are made to rotate synchronously by means of a cord weighted at both ends and passing once around both of them. The curve *Y Y* is produced by one revolution of the tube and *X X* by replacing the tube by a distance piece between the calipering points equal in size to the nominal diameter of the tube being tested, the distance between these lines showing to scale the variation of actual from standard diameter for any given cross section.

* * *

The confusion of sizes of hydrant nozzles for cities and towns of the United States has been the subject of considerable discussion and the folly of such lack of uniformity has often been pointed out. While it is generally appreciated that there is an entirely too large number of so-called standards in different towns we doubt that it is generally known how large the number of such standards really is. The Ludlow Valve Mfg. Co., of Troy, N. Y., have a gage room containing nothing but hydrant nozzle standards for about 7,000 cities and towns, most of which are in the United States, a few being in Canada and England. In this room there are (or were in January) 889 nozzle sizes, all different, where three, or at most, five standard sizes would be sufficient. Standard nozzle connections for 2, 2½, 3, 4 and 4½-inch hose would be practically all that is necessary for almost any town or city, and if such standards could be adopted it would mean that concerns like the Ludlow Co. could make hydrants an article of standard manufacture, whereas they are now made to order only, for the lack of uniformity in nozzles makes it impossible to carry a stock of these goods, except it may be for cities like New York, Boston, or Chicago, whose standards have been widely copied. Consequently the cities have to pay a higher price for hydrants and at the same time often run the risk of not being able to call on neighboring towns in case of disastrous fires.

* * *

A feature of incandescent electric lighting in shops and factories that has been greatly neglected is the provision of proper connections from the wire mains to the lamps used on the machines. The common practice has been to carry a double flexible cord from the nearest lamp socket to a portable lamp hung on some rickety fixture attached to the machine. That this practice is not only slovenly but dangerous besides has been frequently proven by the unfortunate experience of operators who have been badly shocked or burned by short circuits. Not only this, but the use of lamp cord in such a manner is wasteful; it lies around on the floor where the insulation is bruised and soon destroyed, and the amount of cord that may be needlessly used up in a large shop in the course of a year is a considerable item. Where proper attention is given to this feature of machine shop equipment the machines are wired the same as a building, the wires being carried up inside the columns of the machines in insulated cables, and sockets are provided at various convenient points in which a plug, connected to a short length of flexible cord, can be inserted. The nearest socket, of course, is used to suit the convenience of the work. With machines wired in this way the length of flexible cord required is short.

ELEMENTARY DIALING.

JAMES ARTHUR.

The sun dial is probably the oldest means of marking time, and its history is lost in the remote past. The moving shadows of fixed objects must have been observed by primitive man as indicating the passage of the day, and a very natural step after this was to place marks to be reached successively by the shadows; thus dividing the day into periods, ultimately settling down to our twenty-four-hour method. To-day farmers in out-of-the-way places have their "noon marks" reached by the shadow of a tree trunk or other fixed object; and as any ***vertical*** object gives noon just as accurately as a dial the method is still good.

Fig. 1. A Round-faced Dial for Latitude of New York.

Among the ancient references to dials is that to "The Dial of Ahaz" in the Old Testament, and it would be pretty safe to say that that was the only one on which the sun ever went backwards. Coming nearer our times, dials cut on stone become numerous and those cut on the walls of churches and public buildings are comparatively modern. A very quaint one of this kind may be seen in Amsterdam, Holland, and one on the old church in St. Augustine, Florida.

The old cyclopedias nearly always had a large section on "Dialing," and their steel and copper plate engravings were often equal to our best work of to-day. Among books on dials may be mentioned "Sun dials and Roses of Yesterday," by Earle and "The Time Piece of Shadows" by Spackman, both rich in illustrations.

The development of the modern clock caused the dial to decline to a garden ornament, but within a few years there has been a distinct revival, and this is good; for the dial and its supporting column give opportunities for original and artistic treatment to an unlimited extent. As a scientific amusement the construction and setting of dials could hardly be surpassed; since the higher branches require astronomical and mathematical knowledge. The fundamental principles, however, are simple, as I shall try to show.

Referring to Fig. 2 let *N E S W* represent a great circle of the earth corresponding with the meridian of New York City Hall. *S N* is the axis, and at the north pole, *N*, we will erect a horizontal dial, as shown at *A B*, and lining with the axis is the vertical wire *C*, forming the "style" of the dial, being the part which casts the shadow on the dial plate *A B*. We will assume that the earth rotates exactly in twenty-four hours. In midsummer when the sun's rays fall on this dial as per arrow *C* the shadow at 12 noon (or when the sun passes the New York meridian) would fall towards *B* on the 12 o'clock line of the dial. Now, if this dial is divided equally into 24 parts, the shadow of the style *C* will fall on the lines uniformly each hour for the entire 24 hours, since the sun does not set on the north pole during our summer. If you will stick a pin in the center of Fig. 3 you will have this dial. Now we will erect a dial the same on the equator at *W*, but we must keep the same relative position to the axis of the earth and the equator, that is, the style *C″ C‴* must be parallel to the axis *S N* and the dial plate *A′ B′* parallel with the equator, *W E*. The beginner must grasp these elementary steps thoroughly before proceeding further, viz., that any number of dials of this pattern may be erected on the surface of the earth with the plates parallel to the equator, and wires, or styles, parallel to the earth's axis, and that they are all divided into twenty-four equal spaces for the hours, and will mark the sun time. In the case of the dial at *W*, the effect is the same as if the twenty-four-hour rotation took place on the line *C″ C‴* and similarly with all the dials. Note that the dial at *W* is fastened by its edge to the column so as to get it in the same relative position as the north pole dial at *N*. The dial at *W* is double, so that the summer sun as per arrow *C‴* falls on its north side, while the sun at the Equinox falls on its edge as per arrow *A′* and during winter on the south side as per arrow *C′*. This is all very simple; the styles standing up square in the centers of the dials and the twenty-four hours divided equally like the spokes of a wheel, as *K R L Q* in Fig. 3. This brings us to the point which puzzles many persons of education, that is the varying spaces of the hours on a horizontal dial at New York. At *D* (which is the latitude of New York, 40 degrees 43 minutes) is shown a regular horizontal dial, *H I*, the style *F G* being *parallel with the earth's axis*, *S N*, and this is the universal and necessary characteristic of all true dials; so the three dials described all have their styles pointing to the pole star, and dials may be set on a clear night by viewing the edges of their styles to the pole star.

To illustrate the fact that all dials have their lines equally divided, refer to Fig. 3, representing a cylinder, side elevation, *J K*, and end elevation *K L*, which we will suppose to be built up of white wood in twenty-four sections, 1, 2, 3, 4, etc., all glued up with dark-colored glue. The end of this cylinder *K L* represents the two dials *W* and *N*, Fig. 2, the glued joints being the hour lines. Now cut this cylinder on line *M O*,

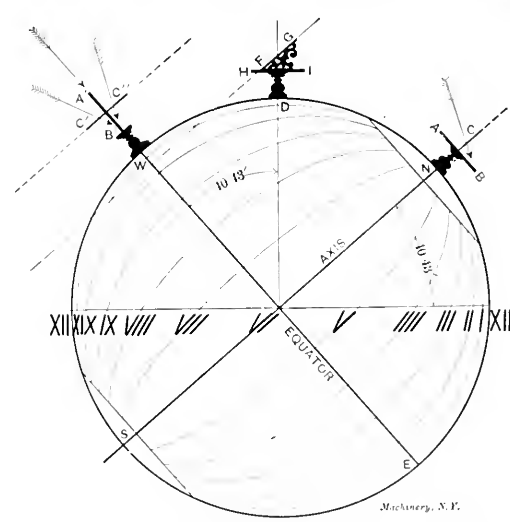


Fig. 2. The Basic Principle of the Sun Dial Illustrated

being 40 degrees 43 minutes to its axis *J K* and the section will be the ellipse Fig. 4, which is a horizontal dial for New York. To show that these lines are correct, a dial of ordinary proportions is shown within the elliptical section, its hours being the glued joint lines.

Further, cut the cylinder to the latitude of any place you please and the section will be a horizontal dial for that place. Still further, you may cut it irregularly, as per line *P*, like the face of a rock at the seashore and it will be a correct dial. You may even turn it on its axis *J K* and set any of the glue joints on the meridian and mark that joint 12 o'clock and it will still be correct. Only one thing you cannot change: the axis *J K*, which we will assume to be a stiff wire, *must be parallel to the earth's axis.*

Imagine the globe, Fig. 2, to be glued up of twenty-four

sections, the meridians being the joints. If this globe is cut on line XII, it will give the lines for a horizontal dial at New York the same as Fig. 4, the axis VI, X being the style of this eight-thousand-mile dial, but this might look a little more difficult to the beginner. This explains the very irregular lines on dials which are cut on the walls of buildings or even on the face of a rough rock cliff. Set up a round stiff rod pointing to the pole star or a solid piece with its edge

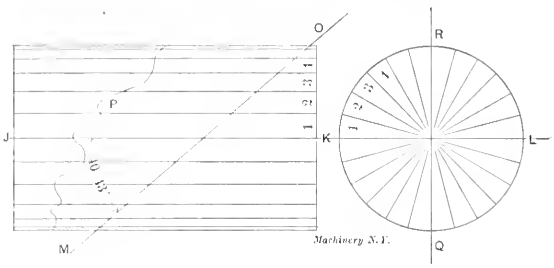


Fig. 3. Development of Dial for Latitude of New York.

so pointing. Now, project imaginary planes from this rod or edge by viewing it at intervals of 15 degrees, but take the first view north for your 12 o'clock line. Where the planes (or views) cut surrounding objects, such as the wall of a building, a rock, or a pavement, cut or paint lines and you have a correct dial. Some of these lines would look very wild, but viewed from the style as the shadow strikes them they are straight lines, just like the glued joints in Fig. 3. All this is to establish the fact that the hours are angles of 15 degrees (or one twenty-fourth the circle) evenly divided around the style. But this glued-up cylinder is only a graphic illustration and need not be made. Let T, Fig. 5, be a solid cylinder mounted in the milling machine as shown and milled off to 40 degrees 43 minutes on section $V U$, being the same as section $M O$ on Fig. 3. Set the machine to 24 and scratch off hair lines by the surface gage X as you register each twenty-fourth and the result will be exactly Fig. 4, which is a New York

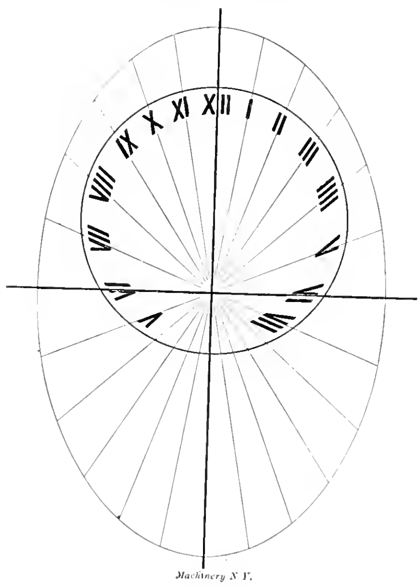


Fig. 4. Showing the Part of the Elliptical Section used in a Dial Face.

horizontal dial. One step more, even the portion of a cylinder, T, is not necessary, but is intended to keep the illustration clear. Any piece of wood or metal fastened to the face plate of the machine in place of T, so long as you can mill a portion of it off to angle $V U$ will be sufficient. Now place on this surface a polished brass plate, $V U$, and proceed to scratch hair lines on it by surface gage and you will have a *master dial plate* for New York, from which dials may be made in any number by mere copying. In other words, when you understand the fundamental principle you may fasten the master dial plate in the machine by any blocking or angle pieces at hand, but it must be 40 degrees 43 minutes to *axis of the dividing head* if you want a New York horizontal master dial.

These hair lines made by the surface gage, of course, require to be cut in a little by using a steel straightedge and a hard sharp point, so as to make this master dial permanent. So far this is done by the milling machine as in general use, but an attachment can be designed which would enable us to mount the dial plate parallel with the table of the machine and then the lines could be cut in by the machine just as we now engrave degrees on a circle. With this attachment, which could be set to the latitude of any desired place, we would have what might be called a dial-engraving machine.

Fig. 1 is a photo-engraving of a complete horizontal dial for New York City made in every respect as described, the lines being engraved on the milling machine. Fig. 6 has same lines, but projected on a square plate, which is merely a matter of taste, as the dial plate may be of any plain or fanciful shape.

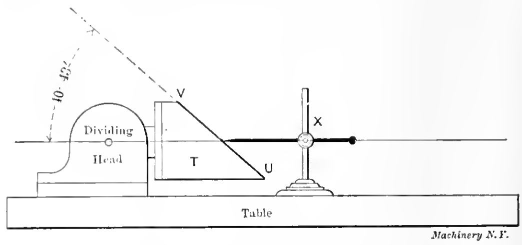


Fig. 5. Scribing the Master Dial.

The books contain methods of laying down a dial on the drawing board, but this method in the milling machine is as accurate as the machine itself and for practical purposes perfect, and free from the personal error in laying down intersecting lines and then drawing final lines through these intersections. It is hardly necessary to point out that for half hours, quarters and five-minute marks the same methods apply, but as this is an elementary chapter on dialing the illustrations are simpler and clearer by showing only hours. For quarter hours set the machine to 96, and for five-minute marks to 288. For similar reasons the variations in sun time, amounting to about half an hour during the year, corrections

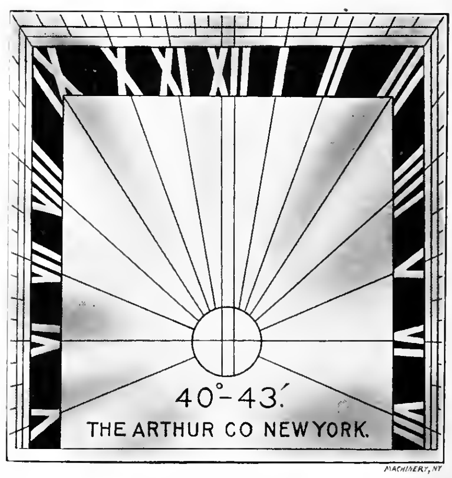


Fig. 6. An Alternative Design of Dial.

for position of "pole star" and errors caused by atmospheric refraction, etc., as well as minute practical instructions for making and setting up dials cannot be gone into here.

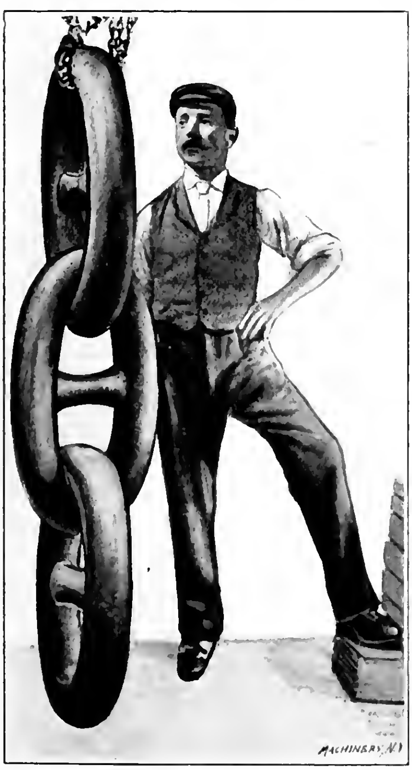
[We consider the foregoing article unique, being, as it is, on the theory of the oldest and most primitive device known to man for marking time, and at the same time showing a scientific method of using a modern machine tool—the milling machine—to lay out a master dial plate for any latitude. The sun dial is an interesting example of projection, the normal

dial, as explained, being an evenly divided 24-space circle at right angles to the polar axis, while the working dial is a projection of the normal dial on a plane tangent to the earth's radius for whatever latitude required. The described method of projection for making the master dial uses a milling machine dividing head in which a wooden block is held and milled off at the required latitude angle to support the master dial blank during the marking off process. Making the supporting wooden block a composite structure with twenty-four sectors simply showed the principle clearer. The transfer of divisions from the master dial to a working dial is readily done with dividers. Mr. Arthur, the writer of the article, as some of our readers know, is a machine shop proprietor in New York City, who is employing part of his leisure time in the study and construction of various horological devices, and the sun dial is the type of timekeeper which he has only recently taken up; and this he is attacking in a characteristically thorough manner. The writer has seen the master plate made for the latitude of New York City, and a demonstration of the method by which it was laid out. It is obvious from the foregoing description that this simple mechanical method of projection eliminates the liability of error, which, of course, is present in the ordinary drawing board method. It should not be inferred, however, that a slight error is of any great consequence in a sun dial, but it is of interest to know that Mr. Arthur has gone at the construction of this ancient timekeeper by scientific and accurate machine shop methods, doing what is probably absolutely new and unique in this direction. —EDITOR.]

* * *

HEAVY CHAIN CABLE FOR NEW CUNARDERS.

The accompanying half-tone cut taken from *Pages Weekly* shows three links from a cable forged by Brown, Lennox & Co. for the new Cunard turbine steamers. The links of these cables are made of 3¾-inch iron and are each 22¼ inches long, the weight being 160 pounds per link. The three links



Links Weighing One Hundred and Sixty Pounds Each.

shown in the illustration were taken for the Admiralty test, and when subjected to a load of 350 tons, did not give way. In fact they were tested with a pull of 370 tons without fracture. Each of the two new Cunarders has two of these cables, each measuring 80 fathoms long, or 480 feet.

W. R. ECKART.*

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Prominent among the able engineers who have contributed largely to the material development of the Pacific Coast stands the name of W. R. Eckart, a man who has stamped his character on much of the foundation work that underlies the splendid structures reared by engineers on the side of our country that faces the Pacific. For the past forty years Mr. Eckart has had some part in the solution of nearly all the great problems that have confronted the mechanical engineer in the development of the material prosperity of the Pacific Coast, and as he began to work on these problems when quite young in his profession, nearly all his fellow workers have now solved the final problem of life. The writer has known Mr. Eckart for over thirty years, working both with and against him in that time, and can bear record to the fact that a good fight with Mr. Eckart was worth something as an education, and to work with him was worth more as an inspiration.

Mr. Eckart was born in Chillicothe, Ohio, June 17, 1841. His relations on the mother's side were pioneers in the settlement of that portion of the State. About 1842 his parents moved to Cleveland, where his father, who was a merchant, had large shipping interests in vessels on the lakes. Young Eckart's education began in private schools. His mother died when he was twelve years of age, and after that his school days were divided between the public schools of Chillicothe and Cleveland, after which he took a special course in mathematics at the St. Clair Street Academy in Cleveland, with the idea of following the profession of civil engineering, one of his relatives being an eminent civil engineer and president of the Marietta and Cincinnati Railroad.

About the middle of the fifties, Mr. Eckart's father moved to Zanesville, Ohio, where he had a managing interest in the Putnam flour mills, the power for which was derived from six waterwheels, each wheel driving "one set of burrs." It was while assisting the millwright in installing improved waterwheels in this mill that he was offered the opportunity to serve an apprenticeship in the works of Griffith, Ebert & Wedge, an establishment that had a high reputation in those days for general mill and steamboat work. The fascination of steamboat engineering had already taken hold of young Eckart while traveling on the Ohio and Mississippi River boats, and he gladly accepted this opportunity. During his apprenticeship Mr. Eckart had the good fortune to secure the friendship of the junior partner and manager of the works, Mr. Wedge. He was a master mechanic of great ability, who had been an apprentice and foreman to Sir Joseph Whitworth when the latter was making known to the world, in his Whitworth works, England, the most accurate methods of machine

* Contributed by Geo. W. Dickie.

tool construction. Mr. Wedge had already installed many of the Whitworth methods of producing accurate work in their shops at Zanesville. Mr. Eckart says that an apprentice was not allowed to pass judgment on his own work as being "good enough." "Good enough," according to Mr. Wedge, was "half spoiled." He always had the patience and the time to show the young mechanic how to make better what he thought was "good enough." Mr. Eckart's reputation for accurate and painstaking work on the smallest details was, no doubt, the result of this early training under Mr. Wedge. He says, "The lesson of patience and accuracy was forcibly impressed upon me at the beginning, when, after a whole day's work devoted to the dressing and finishing of one hexagon nut, I found that it would not pass Mr. Wedge's inspection. His criticism was not finding fault, but a hint to try again. 'You can do it,' and we always got what he wanted in the end, by trying."

Mr. Eckart, while an apprentice, made numerous trips from the works on the trials of new river-boat engines, which resulted in a desire to enter the service of the government as a naval engineer. He applied for permission to be examined as to his qualifications, and at the breaking out of the Civil War he was ordered to appear for examination, June, 1861, and on July 2 he was examined by a board of engineers, of which William H. Shock, chief engineer, was president. His mathematical training, in connection with his shop and steamboat experience, enabled him to pass the examination as No. 1 of his date. It was at this examination that Mr. Eckart met and formed a life-long friendship with the late Prof. R. H. Thurston.

He was appointed third assistant engineer on July 30, 1861, and was ordered at once to join the fleet of naval vessels on the Pacific Coast. While attached to the government vessels in San Francisco harbor in the latter part of 1861, the bright young engineer attracted the attention and made lasting friendships with many of California's foremost men in the engineering profession, including such men as Paul Torqua, Joseph Moore, Irving M. Scott, Wallace Hanscom, Huttner, Specht, and others who did noble work in the engineering development of the Pacific Coast. In July, 1864, Mr. Eckart resigned from the navy on account of ill health and settled in San Francisco. His first work was in the drawing room of H. J. Booth & Co., under the late Irving M. Scott, who was chief draftsman. The principal work in those days was the manufacture of mining machinery and repair work on coast steamships.

On August 30, 1865, the first California-built locomotive was turned out by H. J. Booth & Co., and went on its trial trip from the Mission, San Francisco, to San Jose. The Governor of the State and a large number of officials, on the invitation of the builders, attended the notable event. The designs and drawings for this locomotive were made by Mr. Eckart, chief draftsman for that firm. While on a visit east in 1867 he was examined for and licensed as a first-class chief engineer in the merchant service. He returned the same year to H. J. Booth & Co., and remained with that firm, designing mills and mining machinery, until February, 1869, when he received the appointment of draftsman to the Steam Engineering Department at Mare Island navy yard. Later he was appointed foreman machinist and finally promoted to the position of superintendent of steam machinery, through B. F. Isherwood's recommendation. It was at this time that Mr. Eckart designed the steam machinery, propellers, and dynamometers, for experimental purposes on steam launch No. 4. This boat was undergoing an extensive series of experiments, which created considerable interest at the time, "on the relative efficiency of different propellers"—made by Mr. Isherwood and Mr. Eckart, Records of these tests were published at the time by Mr. Isherwood in a report to the Secretary of the Navy, and by Mr. Eckart in the Transactions of the Institution of Naval Architects, London, 1872, Vol. XIII.

In 1871 Mr. Eckart left the navy yard and the service of the government to enter into partnership with Prescott, Scheidel & Co., at the Marrysville foundry (G. W. Prescott being one of the firm of H. J. Booth & Co.). The name of the Marrysville firm was afterward changed to Booth & Eckart. This foundry being close to the California mines of that time, designed and built a very extensive variety of hydraulic milling and mining machinery. It was while there, with the knowledge gained from experiments on steam launch No. 4, that he was enabled to contract for, and guarantee a speed of 21 miles an hour for the steamer *Meteor*, built for the Carson Lumber Co., to be used on Lake Tahoe. This was, perhaps, the fastest boat of her size known at that date.

In 1872 Mr. Eckart acted as consulting engineer for Sutro in sinking the four air shafts on the line of his tunnel. The investigations then made were a great help later on, both to himself and others who had access to the data collected. It was at this time that the writer of this sketch, then engineer for the Risdon Iron Works, first met and learned to appreciate the ability of Mr. Eckart, not only as a practical master mechanic, but also as a student of engineering problems. At this time he spent months in Virginia City experimenting, taking cards from pumps where the water handled was hot enough to "boil an egg" and the vapors "air-bound the pumps," while the expansion and contraction strains, due to changes of temperature, often wrecked the heaviest castings. The data he collected at this time was of great value to the firm he represented in getting up the designs for the large draining and hoisting plants built by them, such as the Belcher, Yellow Jacket, Ophir, C. and C., and many others.

In the beginning of 1873 Mr. Eckart took up his residence in Virginia City, and became consulting engineer to the "Bonanza firm," consisting of J. W. Mackey, J. C. Flood, J. J. O'Brien and James G. Fair, who owned or controlled nearly all of the "North End" mines. He also acted as manager to the Fulton Foundry. About 1876 large pumping and hoisting works began to be required on the Comstock and the firm of Prescott, Scott & Co., having taken some large contracts for pumping machinery, sent Mr. Eckart to San Francisco to superintend the construction, and to give his valuable aid to Mr. I. M. Scott in the designing of these huge machines. At this time there was a keen rivalry between the Risdon Iron Works and Prescott, Scott & Co. The firm who got in a satisfactory design first obtained the contract, hence the value of a good man like Mr. Eckart, who had been gathering data carefully for the time when it would be needed badly, was appreciated. The Sutro tunnel was, at this date, in 15,500 feet, and with 5,000 feet more to go it would pierce the Comstock lode not lower than the 1,600-foot level. The mine owners already realized that nothing but the heaviest and best-designed machinery would assist them on all the levels yet to be opened below the tunnel, and therefore designs for pumps and hoists of large capacity to reach 4,500 feet below the surface were called for. The difficulties attending the ventilation and sinking of the shafts in virgin ground, which abounded in large but unknown quantities of warm and hot water, were unparalleled in any engineering experience in any part of the world. Such was a part of the engineering requirements to be met and overcome at this early date. The writer considers it very unfortunate that no history of the engineering work done on the Comstock between the years 1875 and 1882 has been written, and Mr. Eckart is one of the few engineers now living who is qualified to write such a history.

It was about this time that Mr. Eckart was made manager of the Fulton Foundry, Virginia City, and was also appointed October, 1878, Deputy Mineral Surveyor for the State of Nevada. During the following two years a large part of his time was occupied in the underground workings of the Virginia and Gold Hill mines, investigating, planning, repairing, and improving the pumps and machinery, as the mines grew deeper and the flow of water increased.

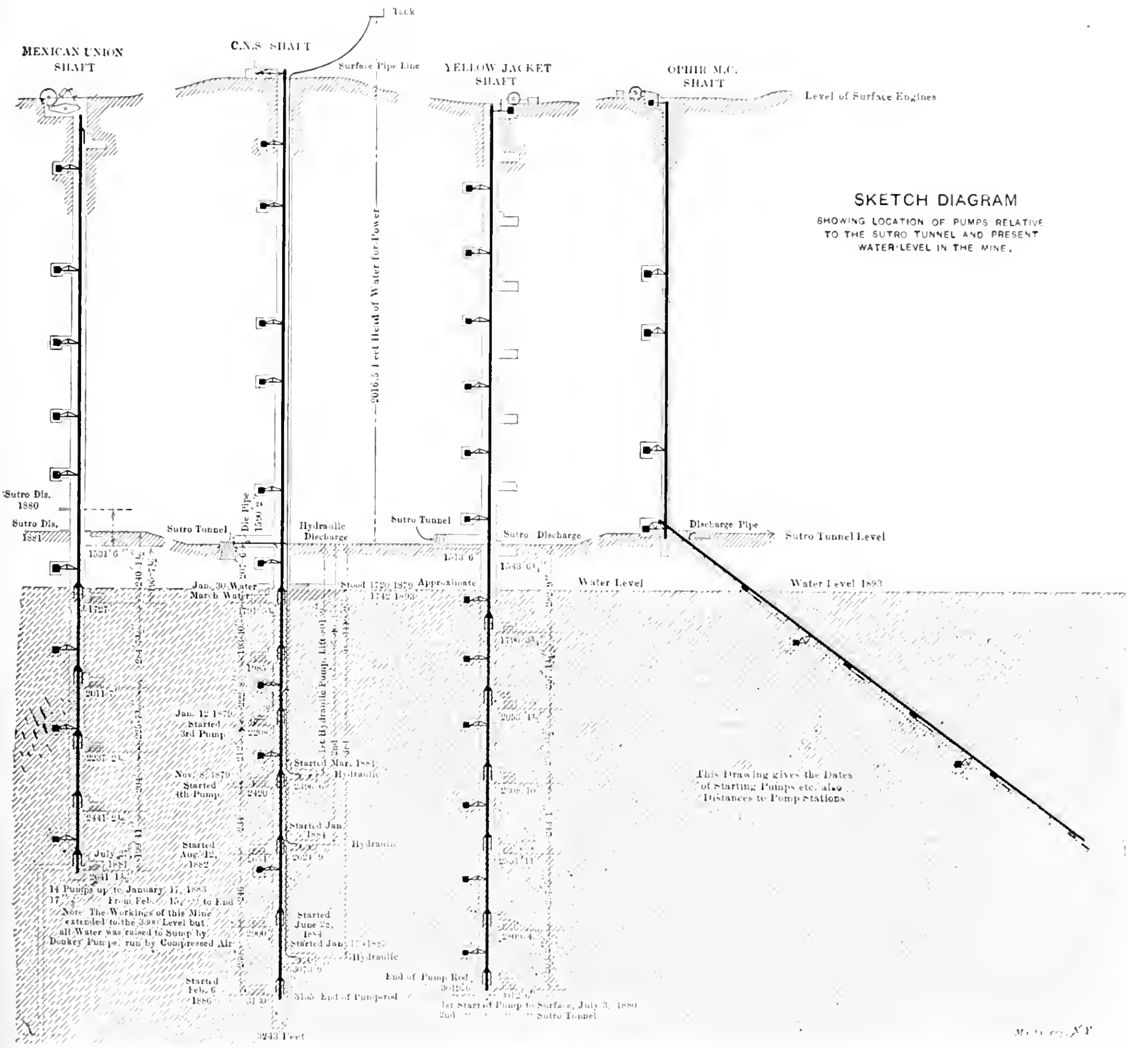
While still a resident of Virginia City, Mr. Eckart designed, and in connection with W. I. Salkald, contracted for and built, the Bulwar Standard Mill at Bodie. This was one of the largest pan mills for working ore built at that time. During the early part of 1880 he was appointed a member of the United States Geological Survey under Clarence King and was given charge of investigating and reporting upon "The Mechanical Appliances of the Comstock Lode." This was congenial work for Mr. Eckart and he went into it heartily and with all his accumulated experience and great ability for accurate work. Nearly two years were spent in collecting data, testing pumps and hoisting machinery, and in making drawings for the government of all machinery on the Comstock lode. The best

instruments procurable in the United States and Europe were used in the various investigations of efficiency. Hydraulic indicators testing from 500 to 3,500 pounds per square inch, made by Elliott Bros., of London, were used in the hydraulic pumps. Chronographs to measure and record the velocities of engines and pump rods, accurate to the one-five-hundredth part of a second, were used on the surface and at a depth of 2,300 feet below ground. By the use of this latter instrument, Mr. Eckart was able to throw light on some problems that had troubled many of us not a little. Diagrams taken from the heavy rods and pumps on the lower levels gave the clue to causes that had been so destructive in the breaking of so many rods and balance bobs in the past. The velocity curves of the pumps and rods revealed the fact not heretofore known (and only in later years properly understood) that the elasticity of long rods could give rise to free vibrations and accelerations due to the engines and pumps. Maximum vibrations and strains resulted at certain parts of the rods which exceeded the elastic limit of the timber of which the rods were constructed. Proper changes in the location of the balance bobs and their weights increased the efficiency of the pumps and checked the destruction of rods and bobs. Some of these velocity diagrams, as well as illustrations of the largest pump engines and hydraulic pumps, were published by Prof. A. Riedler of Berlin while acting as commissioner to the German government in 1893, "*Maschinenarbeit und Ausnutzung der Natur krafte in Amerika*," Vol. II.

While Mr. Eckart had no part in the designing or installing of the large hydraulic pumps already referred to, his investigations of their efficiency afterward added much knowledge on the problems involved in dealing with large bodies of water under high pressure, and a short statement in regard to this work can properly be given in a sketch of his life and work.

In 1880 and 1881 the writer of this sketch designed, and the Risden Iron Works built, installed, and set in operation at the 2,400-foot level of the combination shaft, a hydraulic pump operated from a surface hydraulic pump engine pumping into a surface accumulator which was a huge air vessel 42 inches diameter and 80 feet high, in which from 900 to 1,000 pounds pressure per square inch was maintained. This gave a working pressure on the pipes and pumps at the 2,400-foot station equal to 4,700 feet head. The pumped or mine water was elevated 802 feet to the Sutro Tunnel, while the power water was returned to the surface pumps 2,400 feet above, where it was again pumped into the accumulator, to be used over as power water. A description of this installation was published by Mr. Joseph Moore in "*The Transactions of the Institution of Engineers and Shipbuilders in Scotland*," 1881 and 1882.

Soon after starting, power water was obtained from the pipe lines of the Virginia City Water Power Company and the large surface engines were discontinued. The underground pumps were then run as hydraulic engines, and both mine



Cross-section through Shafts on the Comstock Lode, showing long Pump Rods, Balance Bobs, and Pumps

and power water were discharged into the Sutro Tunnel. In 1881 and 1885 additional pumps were put in on the 2,600 and 3,000-foot levels. At the lower pump the power water was received and operated, the pump under 3,410 feet head discharging the mine water under 1,420 feet lift.

All of this engineering was of a pioneer type as no similar conditions were known. Responsibility for the entire success of the installation was assumed and guaranteed by the builders and their engineers. Many hitherto unknown difficulties due to the excessive pressures, hot water, and the vapors generated from same, were encountered at the start. The writer's hair became gray in three months in the struggle but the difficulties were successfully met and overcome by persistent, painstaking, arduous work. The high altitude of the Comstock mines—the boiling temperature of these being but 202 degrees, added to the troubles from hot water. Several men lost their lives while working around the pumps. An extract from a newspaper of December 4, 1881, says: "Thomas Grant and Thomas Matthews were very severely scalded at the Chollar-Norcross-Savage Shaft. It appears that they were about to change a clack in the hydraulic pumps at the 2,400 level, and in taking off the door of the clack chamber were overwhelmed with a flood of hot water. Mr. Grant received the water across the arms, and though his injuries are very severe, will recover in due time. Mr. Matthews, however, was struck about the neck and the hot water poured down over his whole body and he died Sunday morning." It will be seen from this sad notice that the water had already passed through the pumps and still retained this scalding temperature even when in the discharge columns. The writer knows from his own experience how a drop of water from the roof of this station would raise a blister in the skin. The pump stations and drifts, although supplied with air from enormous fans, had an average temperature of about 96 degrees and were nearly saturated with moisture. Ice in large quantities had to be supplied underground, and cooling stations for miners, had to be erected before drifts could be run. It was under these conditions that Mr. Eckart carried on his experiments, gathering accurate data in locations where existence was a problem that had first to be solved. Then the other difficulties, the hot water and air, for instance, were taken advantage of to a certain extent by the engineers, and compound pumps and underground hoisting engines were designed to utilize the hot water and air of the mines in re-heating the compressed air used in the cylinders for pumping and hoisting, thus greatly increasing the efficiency of all underground machinery over what had been accomplished elsewhere.

Deep mining began to decline about 1880 and Mr. Eckart removed to San Francisco, opening an office as a consulting and constructing engineer. During the following ten years some of the largest and most important mining plants were designed and constructed under his supervision. A notable example is the pumping engine for the Ontario Mine with perhaps the largest Cornish pumps for deep mining ever built in the United States. The pumps were 20 inches diameter by 10 feet stroke, two pumps at each station and operated from one pump-rod 2,000 feet long. (An illustrated description of this machinery will be found in *Engineering News* for November 29, 1894.)

In 1881 Mr. Eckart began plans for all of the Anaconda Copper Works, hoists and reduction work for Haggin & Tevis, and for the following seven years as engineer for that firm all of their mining and mills were planned in his office. The Anaconda Reduction Works in Montana, started as a silver mill, with a capacity of less than 350 tons per day, and increased in size until in 1888 3,000 tons per day could be worked. He also designed and built for the same firm the "Giddes and Bertrand" mill in Nevada, the "Sheep Ranch," "Fine Gold," and "Kentuck" mills of California, the "New Ontario" and "Daly" mills of Utah, the "Guanacevi" and "Jocustitao" mills of Mexico beside work for other firms during the years between 1880 and 1900. Mr. Eckart designed and built the "Quijotoa" and "Mt. Cory" mills for J. C. Flood, the "Cibolo" mill for Boyd and Cook, the "Lexington" mill and hoists at Butte, Montana, "Minas Prieatas" and "Sombrerete" in Mexico. The latter works had two shafts over 1,000 feet deep, and had been filled with water and on that account not worked for over one hundred years, but the water was pumped out and large hoisting works and a chloridizing mill were erected. This was before railroads to that section of Mexico were completed.

When the Union Iron Works began building warships for the U. S. Government, Mr. Eckart, who had always kept in close touch with these works, was appointed consulting engineer and the management often sought his advice on engineering problems connected with the building of these vessels. He was present at and assisted in conducting most of the preliminary and official trial trips and reported on the efficiency of the machinery as shown by the data collected.

In 1896 Mr. Eckart succeeded in getting the water out of the Allison Ranch Mine at Grass Valley, California. Some thirty years before that date water broke into the lower level and drove the miners out and for all those years the mine lay idle and resisted all attempts to drain it. He was also engineer for the Comstock Pump Association from 1890 to 1892 and remodeled the wire rope transmission at the C and C shaft and further examined and made changes in the electrical transmission at the Chollar Mill, Virginia City, from 1888 to 1892. In 1899 Mr. Eckart was appointed consulting engineer to the Standard Electric Co. and afterward became the resident constructing engineer for all of their hydraulic works, including storage-reservoir, ditches, dams, flumes, pipe lines, and power house installation. This was among the first long-distance, high-potential, hydraulic transmission plants projected. The water was to be brought from the "Blue Lakes," situated some 9,000 feet above sea level. The power water for wheels was under 1,400 feet head, and was to develop 15,000 horsepower. This work was successfully completed in 1903. It is odd to find this veteran engineer controlling and using the "ice-cold waters of the Sierras" thousands of feet above sea level and some twenty-five years after his experience in handling and forcing to the surface, from 3,000 feet below the surface, the hot water of the "Comstock Mines."

As to the personality of Mr. Eckart it is pretty closely written all over the engineering development of the Pacific coast. This is what he says of himself: "Whatever success I have achieved in a rather strenuous engineering life covering forty-five years of practice on the Pacific coast has been in a great measure due to a studious life surrounded by an extensive, carefully-collected, engineering library of American and foreign books and the appreciated assistance of associated engineers, together with the encouragement and loyalty of employers."

Mr. Eckart's life has been entirely devoted to his profession perhaps to too great an extent. Only those, among whom the writer is proud to be numbered, who have been associated with him for years, can estimate in any sense the worth of his services to the engineering profession. It is difficult to give any true impression of such a life in such a brief sketch. When the history of engineering on the Pacific coast comes to be written, it will not be complete unless the work of W. R. Eckart occupies the large place in the book that it occupies in fact, and in the experience of his contemporaries.

Mr. Eckart has been honored by membership in the following societies:

American Society of Civil Engineers since 1881.

American Society of Mechanical Engineers since 1882—Vice-President 1883-1885.

The Institution of Mechanical Engineers, London, 1878.

Society of Naval Architects and Marine Engineers, 1893.

American Society of Naval Engineers.

Associate Member The Institution of Naval Architects, London.

* * *

The severe requirements imposed upon automobile gearing have caused some manufacturers to make the teeth of modified form, using 20-degree involute teeth of about three-fourths the height of a standard tooth. For example, 6—8 pitch is considerably used, the dedendum and addendum circles being spaced 1/8 inch from the pitch line instead of 1-6 inch, as would be the case in a standard gear. In this nomenclature, the second figure gives the spacing of the addendum and dedendum circles, and the first the diametral pitch.

THE BELL INDUSTRY.

STORRS ELY EMMONS.

It is not generally known that the bulk of the bells used in the countries of the world are made in the United States, and that about three quarters of these tinklers come from East Hampton, Conn. The factories of this town may be considered the nucleus of the bell industry, and they have a world-wide reputation for both quantity and quality of output.

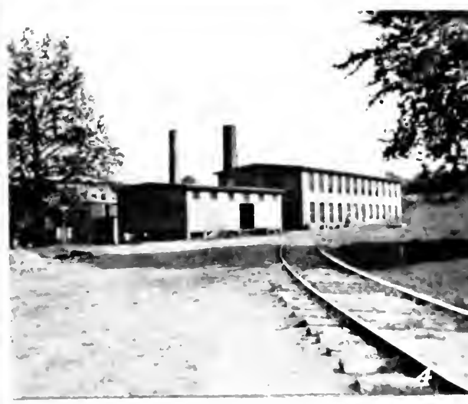
Every conceivable kind of bell is manufactured here, from church to cow bells, and bell toys. The goods are shipped to every country on the Globe. India uses them on her temples; Switzerland orders for her herds, and Prussia for her sleighs.

The industry is of nearly a hundred years standing, having been established in 1808 by Wm. Barton. Prior to this date he was engaged in the manufacture of andirons and brass goods in New York City. It was while there that he became acquainted with a mechanic who suggested the manufacture of sleigh-bells. At this time these were all imported from Europe. The idea was acted upon, and the first plant, small, and crude, was started in East Hampton.

Improvements were soon introduced in manufacturing methods, one of them being to cast sleigh-bells in one piece. This was an innovation, for they were all formerly made in halves in order that the jingle could be inserted, and then either riveted or soldered together. By the new method the jingle was embedded in the sand, forming the core. After the bell was cast the sand was cleaned off, the jingle remaining inside. Barton also lessened the cost of producing church, and hand bells by finishing them on a lathe. Previous to this the work had all been accomplished by hand. The industry thus gained a prestige which it never lost.

In 1827 Wm. Barton's sons, Hiram and Hubbard, took the



1.—Summit Thread Co.
3.—East Hampton Bell Co
5.—Starr Bros. Bell Co.

2.—Bevin Bros. Mfg Co
4.—Silk Mill.
6.—Hill Brass Co

business. Jason, another son, was for a time with the business. He invented the tumbling barrel for finishing bells, now well known, and much improved.

Since that time there have been many changes, both in the mode of manufacture, and in the firms engaged. The power was all by hand at first, but as the business increased it became necessary to utilize the water which flowed in great abundance from Lake Pocatopgue.

Eight firms were engaged in the bell business in East Hampton a number of years ago, but at the present time there are but five. This does not mean that the industry is on the decline, but rather that there has been a consolidation of several of the smaller firms. The present concerns are, Bevin Bros. Mfg. Co., Inc., founded in 1838; East Hampton Bell Co., founded in 1851; Gong Bell Mfg. Co., founded in 1866. The Starr Bros. Bell Co., and the N. N. Hill Brass Co. are of more recent origin.

The East Hampton Bell Co., and the Gong Bell Mfg. Co., are run in conjunction. These two firms, and the N. N. Hill Brass Co. are in the corporation. While the bulk of the work turned out by these three plants is bells, still a considerable number of bell toys are placed on the market, making one of the chief competitors of German importations.

The N. N. Hill Brass Co. make a specialty of struck-up bells, while the Gong Bell Mfg. Co., and the East Hampton Bell Co. are noted for their high-grade cast and turned varieties, such as are used in chimes, musical instruments, etc. An example of a large gong turned out by these people is to be found in the New York Stock Exchange, being 28 inches in diameter.

Bevin Bros. Mfg. Co. have the largest plant exclusively devoted to the manufacture of bells. They are the first on the stream which carries off the overflow from the lake. It stands in striking contrast as to machinery, and methods to Wm. Barton's original shop. Every possible appliance, consistent with a superior article, is used to diminish the cost of production.

The Starr Bros. Bell Co., while of a later birth, is doing a large business, and bids fair to hold up the reputation of the town. The plant is modern as to its appointments.

The village contains 2,300 to 2,500 people out of whom fully 25 per cent work in the bell shops. The balance of the working population is divided between one or two wagon works, a thread mill, a bolt cutting machine plant, and one or two other small ventures. The town is the manufacturing city in embryo.

The economic importance of the location of East Hampton partially explains why they are able to place their goods in all the markets of the world. In the first place the town lies in a rich agricultural district, high, well watered and drained. It is on the "Air Line" division of the N. Y., N. H. & H. R. R., about mid-way between New York, and Boston. A drive of three miles brings one to the river landing, making it possible to get good freight rates. The natural power of the place is of much importance.

The body of water supplying this power is nearly ten miles in circumference. Its average depth is ten feet, being fed by springs, and mountain brooks. The banks are rock-bound, and lead back on three sides to wooded slopes. The side toward the outlet of the lake is sandy and shelving. The bank at this point reaches its maximum height, about seven feet, some 400 feet from the shore line. Here the first fall of the stream is found. From this first drop to the place where the stream flows into Salmon River, a distance of about nine miles, the waters of the lake fall about 460 feet.

As with most such sources of power the water in the lake becomes low during a protracted dry spell. While the lake has never failed to yield sufficient energy (1,000 H. P.), still, owing to the increasing activity, it is now being considered advisable to put in a dam of sufficient size to raise the surface of the lake twelve inches, and it is understood that some rights have already been purchased for this purpose.

* * *

Don't forget that a mill file pushed diagonally across a shaft in the lathe will cut off a great deal more metal in the same time than it will if it is pushed square across.

MAKING A BLANKING DIE.

C. F. EMERSON.

From a mechanical standpoint it can truthfully be said that we are living in an age of dies. Never before has the industrial world made use of the punch and die as it is doing to-day. And no wonder; for this useful tool in all its different phases has proven beyond all reasonable doubt that it can turn out more work in less time than the combined efforts of a room full of milling machines, shapers and drill presses.

To those who are unfamiliar with the die and its work the above may not appear feasible; but one has only to visit a modern sheet metal factory to be convinced of the surprising rapidity with which the power press with its punches and dies will turn out not only accurate work, but work of all kinds of shapes and sizes.

Of the many different kinds of dies in use, the blanking die is probably the most widely used. The reason for this is that almost all work that requires the use of various other kinds of dies has its beginning with the blanking die; for it is this die that cuts the work from the flat stock before it is completed by the other dies.

In making the blanking die there are a few essential things to be taken into consideration, among which are the following:

1. Use good tool steel of a sufficient length, width, and thickness to enable the die to hold its own.

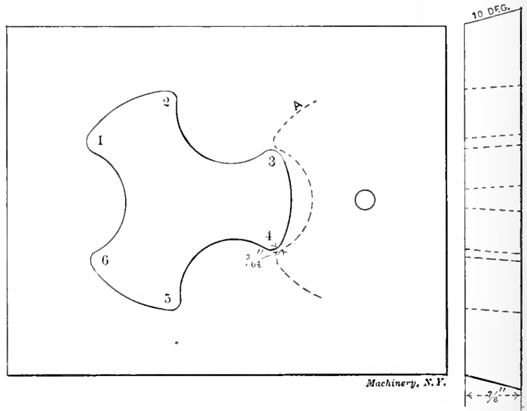


Fig. 1. The Die to be Made.

2. In laying out the die care should be taken that as little of the stock as possible is left over, as waste, in cutting out the blanks.

3. Be sure not only that the die has the proper amount of clearance (which should be no more than two degrees and no less than one degree); but also that the clearance is filed *straight*, so as to enable the blanks to readily drop through.

4. In working out the die, machine out as much as you can; don't let the file do it all.

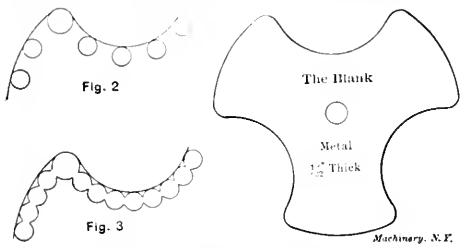
5. In hardening the die do not overheat the same, as the cutting edge of a die that has been overheated will not stand up to the work, and requires so much sharpening in order to produce perfect blanks, that at its best it is nothing more than a nuisance.

In laying out the blanking die the face of the die is first polished smooth and drawn to a blue color by heating. This gives better satisfaction by far than using coloring acid, for it gives a clear white line on a dark surface to work to and is easier on the eyes, particularly when working by artificial light as is often necessary. When the die to be laid out is a blanking and piercing die, allowance of 3-64 inch must be made for the "bridge," *i. e.*, the narrow strip of metal that separates the holes in the stock from which blanks have already been cut. Fig. 1 shows how this is done; the dotted line *A* is drawn merely to show how the die is laid out.

After the die is laid out it is ready to be worked out. Now there are several different ways of working out the surplus stock in a die of this kind. One is to drill say a half-inch

hole at a safe distance from the line and then fasten the die in a diemaker's milling machine and mill the stock out close to the line with a taper milling cutter, which gives the die the necessary clearance, thereby saving considerable time when filing out the die.

Another method, which is most commonly used, is to drill out the surplus stock on a drill press, after the manner shown in Figs. 2 and 3, which is done as follows: The six holes for the corners numbered 1, 2, 3, 4, 5, 6, Fig. 1, are first drilled and reamed taper, after which the other holes are drilled. These holes are drilled an even distance apart, and must therefore be spaced off, and then spotted with a prick



Methods of Outlining the Blanking Die.

punch before they are drilled. The best way to do this is to first scribe an inside line at a distance from the outside line equal to one-half the diameter of the holes to be drilled, then space off, and spot. In spacing off don't use your dividers, use a double prick punch. Using a pair of dividers takes up too much time, besides the points get dull quickly enough without using them when it is unnecessary. After the line has been lightly spotted with the double prick punch, use an ordinary prick punch and make the spots a trifle deeper so that the drill will more easily take hold.

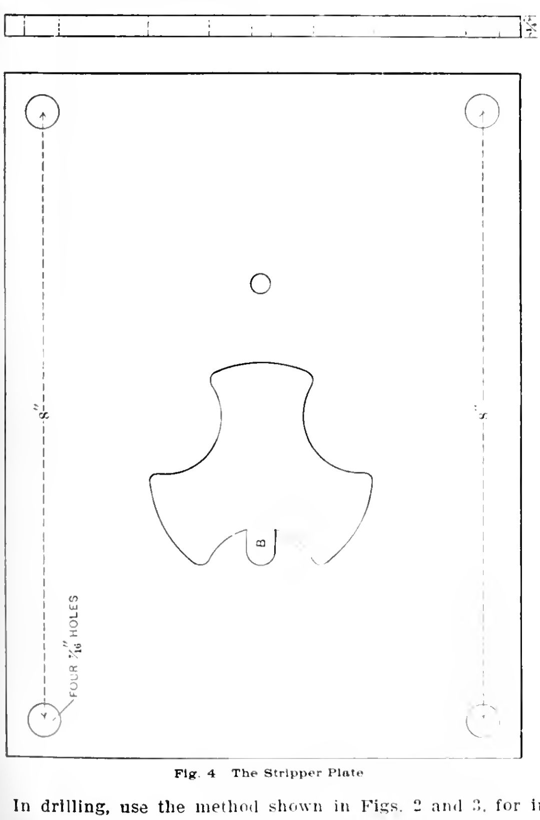


Fig. 4 The Stripper Plate

In drilling, use the method shown in Figs. 2 and 3, for in this way the holes can be drilled closer together, thereby making it easier to get rid of the surplus stock and saving the time of broaching out the webs. The die blank should be slightly tipped by placing a narrow strip of flat stock under the edge of same, as shown in Fig. 6, when the die is being drilled. This is done to give the necessary clearance, and does away with that time-killing operation of reaming the holes with a taper reamer from the back after they are drilled. After the surplus stock is gotten rid of the die is finished up by filing, using a coarse file to begin with and finishing with a smooth one.

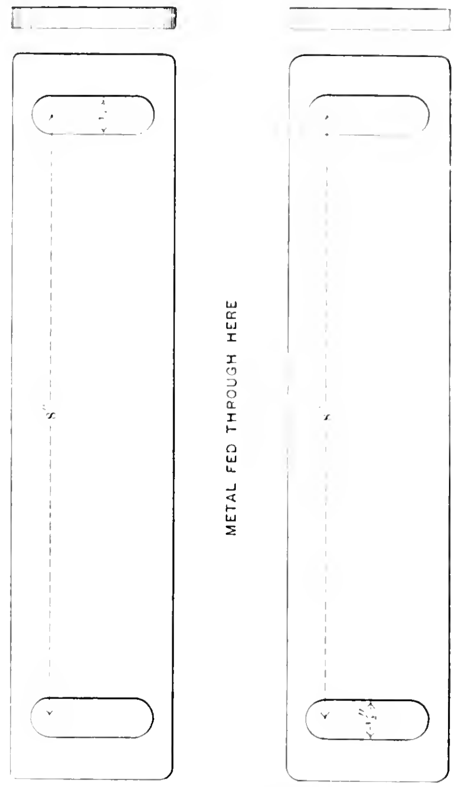


Fig. 5. The Gage Plates.

Usually the die is made to fit a sample blank or a template. This is done by entering the template from the back as far as it will go after the die has been filed to the inside of the line. A lead pencil is then used to mark that part of the die where the template bears. The template is then removed, the pencil marks filed out, the template again entered and so on until it is worked through the die.

In filing out a die of this kind where there is any danger of filing out that part of the die which has already been

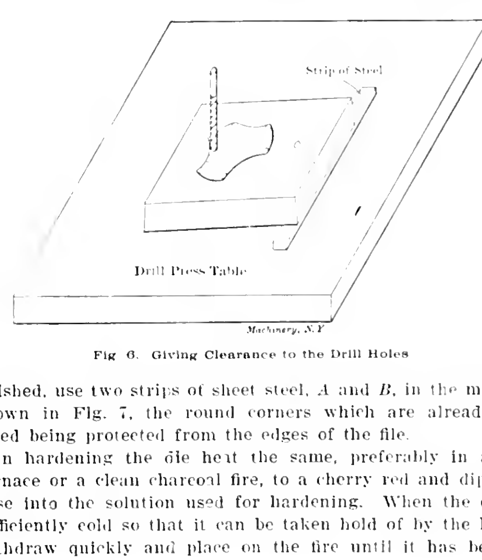


Fig 6. Giving Clearance to the Drill Holes

finished, use two strips of sheet steel, A and B, in the manner shown in Fig. 7, the round corners which are already finished being protected from the edges of the file.

In hardening the die heat the same, preferably in a gas furnace or a clean charcoal fire, to a cherry red and dip endwise into the solution used for hardening. When the die is sufficiently cold so that it can be taken hold of by the hands withdraw quickly and place on the fire until it has become

so warm that it will make water sizzle when dropped thereon; then immerse once more until cold. This is done to relieve the internal strains caused by hardening, and acts as a preventive to cracking.

The face of the die is now polished and the temper drawn to a light straw color, after which the die is allowed to cool of its own accord in oil. When cool the die is ground on a surface grinder on the top and bottom and if it is required it is lapped to size, which completes the operations.

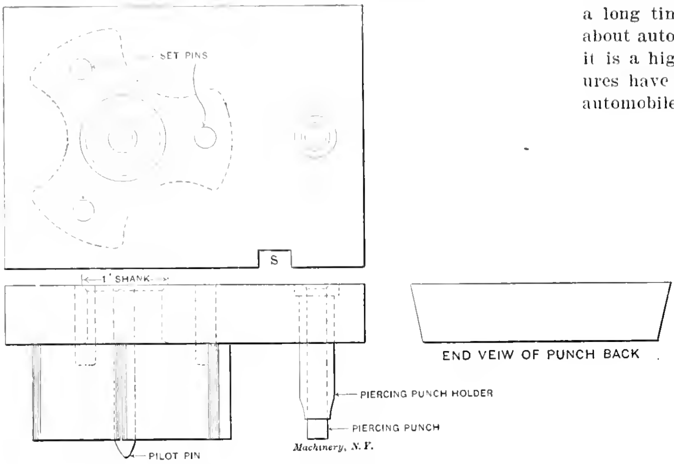


Fig. 8. The Punch.

The punch is made after the manner shown in Fig. 8, and needs very little explanation. The dovetail punch back shown holds the punches in position and is securely held in the press by the aid of a key. The slot *S* forms a position stop by engaging in a stud in the dovetail channel in the ram of the press, thereby eliminating the necessity of again resetting the tools in case the punch requires sharpening.

The blanking punch is made from a tool steel forging, and is machined and sheared through the die in the usual manner. The one-inch shank is made a good driving fit in the punch back and is upset as shown after the punch is driven in. The three set pins help to more securely hold the punch in position and prevent it from turning.

The piercing punch is held in position by the piercing punch holder which is driven tight in the punch back. The piercing punch is lightly driven in and is made of drill rod and can be very readily replaced in case it is broken. The pilot pin is also made of drill rod and can be very easily and quickly taken out when the punch requires sharpening.

The stripper and gage plates for this die are shown in Figs. 4 and 5. They are fastened by 4 7-16 cap screws to the die bed, used for holding the die in position when in use, and form, in the writer's opinion, not only the best, but by far the cheapest of the various methods he has come in contact with. While this method cannot be used on all kinds of blanking dies, it can, however, be used with the best of results on dies similar to the above and does away with the unnecessary operation of drilling and tapping holes in the die itself to hold the stripper and gage plates in position. Not only that, but the gage plates as shown are used in connection with many other dies of a similar nature, thereby doing away with the necessity of having a set of gage plates for every die, as is the case in some shops.

As the sketches speak for themselves, no more explanation seems necessary except perhaps that the slot *B* shown in Fig. 4 is to allow for an automatic finger to act as a position stop for the metal when it is run through.

* * *

Professor Pierre Curie, the famous discoverer of radium, was run over by a wagon in the streets of Paris, France, and killed April 19, 1906. Prof. Curie was about 57 years old, and began his scientific research work before leaving school. He was greatly assisted in his researches by his wife, Madame Curie, and it is really to her that the greater part of the honor of the discovery of radium is said to be due.

COST OF AUTOMOBILE OPERATION.

It requires an optimistic mind to think of the automobile truck supplanting the horse-drawn truck or any form of the motor-driven vehicle competing successfully with the horse at present, except where the cost of operation is a secondary consideration. The price of gasoline makes the fuel account a costly item, and this with the repairs for tires and periodical overhauling of the machinery, together with the unreliability of such vehicles, seems to indicate that their universal use is a long time in the future. Every one who knows anything about automobiling for pleasure, knows, in a general way, that it is a highly expensive sport, but very few authoritative figures have been published, giving the individual experience of automobile users. The May issue of *Country Life in America*

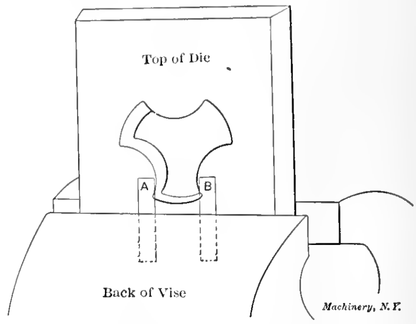


Fig. 7. Guarding the Corners in Filing the Die.

contains an article in which the author opens his heart and account book and tells the reader something of what they may expect to happen to their pocketbooks in case they buy a touring car costing, say, about $2,500 and seating six people. His purchase was a 20-horse-power double-cylinder machine, weighing about 3,000 pounds and costing $2,630 with certain extras. The cost of operation and depreciation are given in the following, from which it appears that for ten months' use the total expense was $1,473.76, or an average monthly expense of $147.37. During this period of ten months the car covered an approximate distance of 8,000 miles, and is claimed to have carried an average of six passengers. On the basis of 48,000 passenger miles, this figures out 3.07 cents per mile per passenger, or more than the average local railroad fare in the Eastern States. It will be observed that the most favorable condition is assumed in that the car was carrying an average of six passengers all the time, whereas in most cases the average number of occupants would probably not have been more than three, thus doubling the cost per passenger mile, and with no appreciable reduction in the cost of operation. The owner was fortunate in not having any serious breakdowns or smashups such as befall a considerable number of the automobiling fraternity.

First cost of machine	$2,600.00
Interest on investment at 6 per cent (ten months)	130.00
Twenty-five per cent depreciation for use (making present high market value $1,950)	650.00
Gasoline	120.15
Lubricating oils, greases, etc.	18.25
Mechanics' time overhauling, repairing and adjusting	89.78
Cost of new parts bought	58.30
Insurance expense	95.00
Tire expense	176.88
Storage expense	123.00
Batteries	6.00
Carbide for lamps	6.40
Total	$1,473.76
Average monthly expense	147.37

In the above it will be noted that a depreciation of 25 per cent is marked off for the ten months' use, and this, of course, makes the monthly operation cost high. But this depreciation is none too liberal for a pleasure car, although it would probably be somewhat excessive for a purely commercial vehicle.

* * *

Don't run a polishing wheel on brass for any length of time without wearing a wet sponge over your mouth and nostrils.

A NEW FORMING LATHE.

We are indebted to our contributor, Mr. James Vose, Manchester, England, for particulars regarding a forming lathe built under Siebert's patents by John Holroyd & Co., Ltd., Milnrow, Manchester, England, which is shown in the illustrations, Figs. 1 and 2. The interesting feature of this lathe is a forming arrangement designed in this particular instance for the rapid production of duplicate test pieces of tire steel, etc., though this feature is applicable to many other uses, such as automatic forming in connection with forming lathes for all varieties of work, even for work as large as railroad axles.

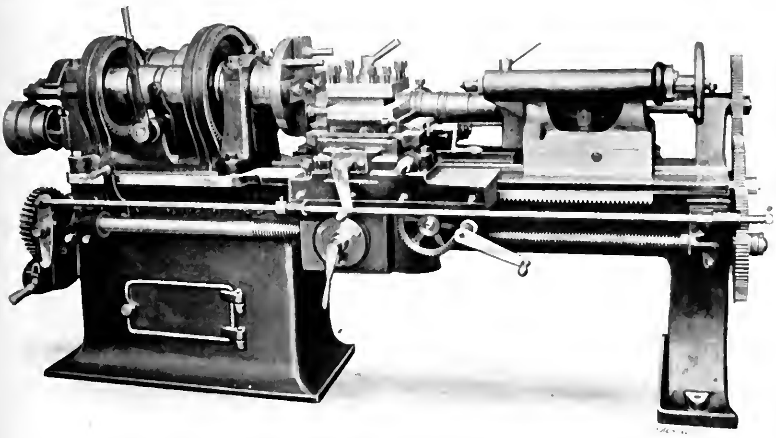


Fig. 1. Front View of Forming Lathe built by John Holroyd & Co.

The headstock carries a steel spindle running in parallel gun-metal bearings. The cone pulley is carried on a rear spindle and drives the main spindle of the lathe through either of two sets of gears, one driving the lathe at twice the speed of the other. The change from one speed to the other is rapidly made by means of a handle conveniently placed in front, which shifts a positive clutch on the main spindle.

The lathe carriage is fitted with a compound slide and square steel turret for holding tools. It has a hand movement by rack and pinion and a power traverse movement by the guide screw and a double clamp nut. The guide screw receives its motion through a worm and worm wheel and a train of gears driven by a belt and the small cones at the headstock end of the lathe. Six changes of feed are secured through the three steps of the feed cones and a two-speed gear box, the feed being disengaged automatically at any desired point by tripping a drop worm box. At the rear of the lathe is a scroll-type former carried on a splined shaft driven through gearing at the same speed as the guide screw. The scroll is mounted between two sliding uprights that are given a traverse motion on the auxiliary ways at the rear of the lathe by means of a screw operated by the feed gearing. The traverse motion of the scroll is in a direction opposite to the longitudinal travel of the lathe saddle. It will thus be seen that the shape of the piece being formed is governed both by the shape of the scroll and the distance traveled by the scroll in a given time, relative to the travel of the cutting tool. The length of the scroll thus may be varied in any desirable proportion to the length of the object being formed, making it possible to secure abrupt changes of contour in the piece being formed without having corresponding abrupt changes in contour of the scroll. There is thus small tendency to bind the cross slide, owing to side thrust upon the roller which bears against the scroll.

In the lathe illustrated, the arrangement of speeds and feeds and the locking arrangements of the cross slide allow the operator to take a heavy cut over the work in the usual manner; then, after changing the speeds and feeds, he unlocks the cross slide, allowing it to be controlled by the roll bearing against the scroll and takes the forming cut. In Fig. 3 are photographs of four scrolls of different shaped pieces of work and one test bar that has been turned up is also shown. The surfaces of the scrolls form what is really a continuous path from end to end, increasing or diminishing in diameter as required. The scroll is cut to the required shape in position by a small milling head, using an end mill, which is supplied in addition to the usual lathe accessories. This mill cuts a flat spiral path which the flat roll attached to the cross slide follows. For the particular duty for which the lathe illustrated was designed, one scroll only is required and a weight is employed to hold the forming slide against the scroll when the cutting tool is idle. When the cutting tool is in progress the tendency to keep the slide in contact with the scroll is increased by the pressure against the tool. On some heavy classes of work the weighting is omitted; two forming scrolls located inversely to each other control a bowl, carried on a prolongation of the forming slide.

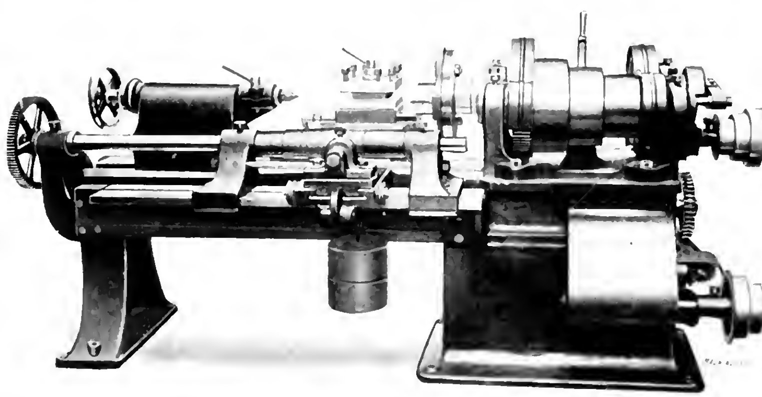


Fig. 2. Rear View of Lathe, showing Forming Cam.

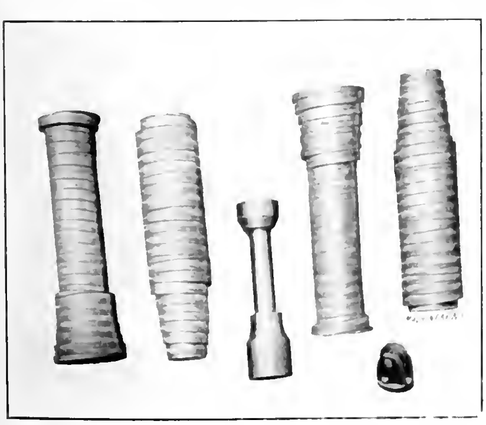


Fig. 3. Forming Cams and Sample of Work

* * *

Don't forget that a lathe may be made to bore larger or smaller at one end or the other by setting the tool above, or below, or exactly on the center.

PROPOSED STANDARDS FOR MACHINE SCREWS.

A committee appointed by the American Society of Mechanical Engineers to investigate the subject of machine screw proportions and to recommend standard specifications for machine screws, made its first report at the last annual meeting. A second, and what was intended to be a final report of the committee, was presented at the Chattanooga meeting; but in the discussion which followed there were various and widely divergent criticisms of the report. The committee was therefore continued and will again report at the next annual meeting. The work of the committee has advanced to such a point, however, that the following abstract of the report will be of interest, but it should be borne in mind that this is subject to revision and is not final. The diameters and pitches, with the method recommended for establishing and maintaining them, are given herewith, together with proportions for machine screw heads. Considerable attention was given in the report to the question of size limits, but space will not be taken in this abstract to cover this part of the question

TABLE I. STANDARD MACHINE SCREWS.
(Thread U. S. Form.)

Standard Diameter.	Number of Threads per Inch.
0.070 in.	72
0.085	64
0.100	56
0.110	48
0.125	44
0.140	40
0.165	36
0.190	32
0.215	28
0.240	24
0.250	24
0.270	22
0.320	20
0.375	16

Form of Thread.—The Sellers, or U. S. form of thread, having an included angle of 60 degrees, and a truncation or flat at the top and bottom of the thread equal to one-eighth of the pitch of the thread, shall be used for the basic standards.

The form of thread for machine screws shall have an included angle of 60 degrees, a truncation or flat at the top of the thread equal to one-eighth of the pitch, and a truncation at the bottom of the thread equal to one-sixteenth of the pitch.

TABLE II. STANDARD REFERENCE THREAD GAUGES.

Standard Gauges for Taps. U. S. Form, except at Top of Thread, which is flat $\frac{1}{16}$ Pitch.				Basic Standard. Reference Thread Gauges, U. S. Form.				Standard Gauges for Screws. U. S. Form, except $\frac{1}{16}$ flat at Root.	
Diam. at Top of Thread.	Diameter at Root of Thread.	Pitch Diameter.	Excess Pitch Diameter over Basic.	Diameter Top of Thread.	No. Threads per inch.	Diameter Root of Thread.	Pitch Diameter.	Diameter Top of Thread.	Diameter at Root of Thread.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
.07209	.05255	.06157	.00059	0.070	72	.05196	.06098	0.070	.05046
.08732	.06533	.07548	.00063	0.085	64	.06470	.07485	0.085	.06301
.10260	.07747	.08907	.00067	0.100	56	.07680	.08840	0.100	.07487
.11298	.08366	.09719	.00072	0.110	48	.08294	.09647	0.110	.08068
.12821	.09623	.11099	.00075	0.125	44	.09548	.11024	0.125	.09302
.14350	.10831	.12455	.00079	0.140	40	.10752	.12376	0.140	.10482
.16884	12975	.14779	.00083	0.165	36	.12892	.14696	0.165	.12591
.19427	.15029	.17058	.00088	0.190	32	.14941	.16970	0.190	.14603
.21981	.16955	.19275	.00094	0.215	28	.16861	.19180	0.215	.16474
.24553	.18689	.21396	.00102	0.240	24	.18587	.21294	0.240	.18136
.25553	.19689	.22396	.00102	0.250	24	.19587	.22294	0.250	.19136
.27599	.21202	.24155	.00107	0.270	22	.21095	.24048	0.270	.20603
.32653	.25617	.28864	.00111	0.320	20	.25505	.28753	0.320	.24964
.38302	.29506	.33566	.00125	0.375	16	.29381	.33441	0.375	.28704

NOTE.—Diameter at root of thread, for basic standard gauges,

$$= \text{standard diameter} - \frac{1.2990381}{\text{No. of threads per inch}}$$

Diameter at root of thread for standard gauges for screws = basic root diameter − P (0.10825).

Diameter at top of thread, standard gauges for taps = standard diameter + 1 P × 0.005 + P (0.10825).

The form of thread for machine screw taps shall have an included angle of 60 degrees, a truncation or flat at the top of the thread equal to one-sixteenth of the pitch, and a truncation or flat at the bottom of the thread equal to one-eighth of the pitch.

Diameters and Number of Threads per Inch.—The list of screws adopted consists of 14 sizes having outside diameters and numbers of threads per inch as per Table I.

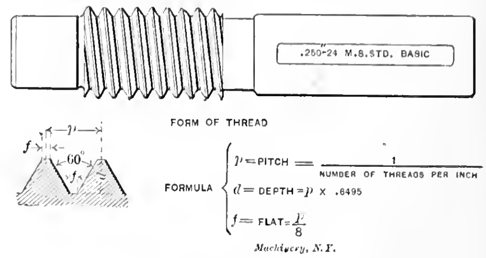


Fig. 1. Reference Thread Gauge

Standard Reference Thread Gauges.—As stated in the paper by Mr. Chas. C. Tyler (pages 608-9, Vol. XXIII., *Transactions* A. S. M. E.), in order "To secure the interchangeability of machine screws and taps, a practical system of gauging should be provided, and ultimate standards of reference are desirable, particularly in cases of disputed thread sizes. The modifications of the form of thread for screws and taps to give clearance, each being based on the United States standard thread, make it seem desirable to provide three sets of standard reference thread gauges for each gauge diameter; one basic, one for screws, and one for taps."

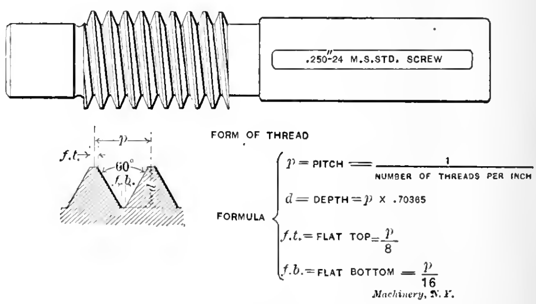


Fig. 2. Thread Gauge for Screws.

The thread dimensions of these standard reference thread gauges are given in Table II.

The pitch diameters, given in the eighth column of Table II., are the diameters when measured in the angle of the thread, at points equi-distant from the top and bottom of the threads of the basic standards.

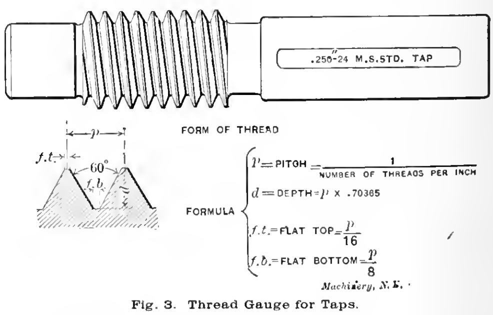


Fig. 3. Thread Gauge for Taps.

Basic Standard Reference Thread Gauges.—Following further the text of Mr. Tyler's paper, referred to, with slight modifications, your committee recommends as the foundation of the system, a set of basic standard reference thread gauges, these gauges to be made of unhardened steel, of 0.35 per cent to 0.40 per cent carbon, to represent exactly, in every detail, the U. S. form of thread, the diameter at the top of the thread, the diameter at the bottom of the thread, and the correct pitch; the included angle of 60 degrees, and the flat at top and bot-

tom of the thread equal to one-eighth of the pitch. Each basic standard gauge to have plainly marked thereon the diameter, number of threads per inch and "M. S. Standard Basic" (machine screw standard), as shown in Fig. 1, herewith. The basic standards to be used only for comparative calibration, in the making of the reference standard plug thread gauges for screws and taps. (See columns 5, 6, 7 and 8, Table II.)

Standard Reference Thread Gauges for Screws.—These gauges are to be made also of unhardened steel, 0.35 per cent to 0.40 per cent carbon, to represent exactly, in every detail, a screw having the modified U. S. form, *i. e.*, a flat at top of one-eighth of the pitch, and at bottom of one-sixteenth of the pitch, with an included angle of 60 degrees, the exact diameter at the top and at the bottom of the thread, and the correct number of threads per inch. Each standard gauge for screws to have plainly marked thereon the diameter, number of threads per inch, and "M. S. Standard Screw," as shown in Fig. 2.

The gauges for screws should be exact duplicates of the basic standards, in external diameter, pitch and number of threads per inch, also in pitch diameter, measured in the angle of the thread, but to be less in diameter at the bottom of the thread, corresponding to the decreased width of flat, which at this point is one-sixteenth of the pitch. These decreased root diameters are given in column 10, Table II.

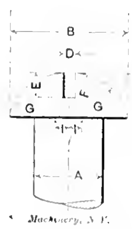
All details for measurement, for basic and reference thread gauges for screws, are given in Table II., excepting only those for width of flat.

Standard Reference Thread Gauges for Taps.—These gauges are also to be made of steel, 0.35 per cent to 0.40 per cent carbon, unhardened, to exactly represent in every detail, the size of a threaded tap before being fluted, having the included angle 60 degrees, the flat at top one-sixteenth of the pitch, with flat at bottom of the thread equal to one-eighth of the pitch, and to correctly represent the standard pitch of thread. The external diameters to be as given in column 1, Table II.

The increased external diameters there given are due to allowance for flat of one-sixteenth of the pitch and for error of lead due to hardening, as already mentioned in a preceding paragraph.

TABLE III. ROUND HEAD MACHINE SCREWS.

A = Diameter of Body.
$B = 1.83A$ = Diameter of Head.
$C = 0.703A$ = Thickness of Head.
$D = 0.235A$ = Width of Slot.
$E = 0.40A$ = Depth of Slot.
$F = 1.095A$ = Rad. of Top of Head.
$G = 0.70A$ = Rad. of Sides of Head.
$H = 0.068A$ = Dist. from Bottom of Head to Center of G.
$I = 0.213A$ = Dist. from Center of Head to Center of G.



A	B	C	D	E	F	G	H	I	Thr'ds per In.
.070	.1281	.0492	.0164	.0280	.0766	.0490	.0048	.0149	72
.085	.1555	.0597	.0200	.0340	.0931	.0595	.0058	.0181	64
.100	.1830	.0703	.0235	.0100	.1095	.0700	.0068	.0213	56
.110	.2013	.0773	.0258	.0440	.1204	.0770	.0075	.0234	48
.125	.2287	.0879	.0294	.0500	.1369	.0875	.0085	.0266	44
.140	.2562	.0984	.0329	.0560	.1533	.0980	.0095	.0298	40
.165	.3019	.1160	.0388	.0660	.1807	.1155	.0112	.0351	36
.190	.3477	.1336	.0446	.0760	.2080	.1330	.0129	.0405	32
.215	.3934	.1511	.0505	.0860	.2354	.1505	.0146	.0458	28
.240	.4392	.1687	.0564	.0960	.2628	.1680	.0163	.0511	24
.250	.4575	.1757	.0587	.1000	.2737	.1750	.0170	.0532	24
.270	.4944	.1898	.0634	.1080	.2956	.1890	.0184	.0575	22
.320	.5856	.2250	.0752	.1280	.3504	.2240	.0218	.0682	20
.375	.6862	.2636	.0881	.1500	.4106	.2625	.0255	.0799	16

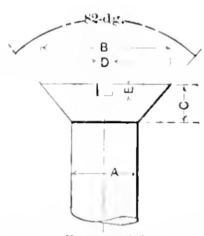
TABLE IV. FLAT HEAD SCREWS.

A = Diameter of Body.
$B = 2A = 0.0052$ = Diameter of Head.

$$C = \frac{A - 0.0052}{1.739} = \text{Thickness of Head.}$$

$D = 0.235A$ = Width of Slot.

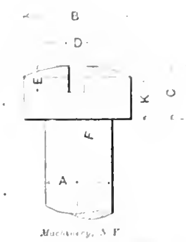
$$E = 1\text{-}3C = \frac{A - 0.0052}{5.217} = \text{Depth of Slot.}$$



A	B	C	D	E	Threads per In.
.070	.1348	.0373	.0164	.0124	72
.085	.1648	.0459	.0200	.0153	64
.100	.1948	.0545	.0235	.0182	56
.110	.2148	.0603	.0258	.0201	48
.125	.2448	.0689	.0294	.0229	44
.140	.2748	.0775	.0329	.0258	40
.165	.3248	.0919	.0388	.0306	36
.190	.3748	.1063	.0416	.0354	32
.215	.4248	.1206	.0505	.0402	28
.240	.4748	.1350	.0564	.0450	24
.250	.4948	.1408	.0587	.0469	24
.270	.5348	.1523	.0634	.0508	22
.320	.6348	.1816	.0752	.0605	20
.375	.7448	.2126	.0881	.0709	16

TABLE V. OVAL FILLISTER HEAD SCREWS

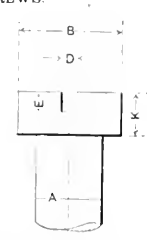
A = Diameter of Body.
$B = 1.6A$ = Diameter of Head.
$C = 0.80A$ = Thickness of Head (oval).
$D = 0.235A$ = Width of Slot.
$E = 0.5C = 0.4A$ = Depth of Slot.
$F = 2.186A$ = Radius of Head.
$K = 0.65A$ = Thickness of Head (flat).



A	B	C	D	E	F	K	Threads per In.
.070	.1120	.0560	.0164	.0280	.1530	.0455	72
.085	.1360	.0680	.0200	.0340	.1858	.0552	64
.100	.1600	.0800	.0235	.0400	.2186	.0650	56
.110	.1760	.0880	.0258	.0440	.2404	.0715	48
.125	.2000	.1000	.0294	.0500	.2732	.0812	44
.140	.2240	.1120	.0329	.0560	.3060	.0910	40
.165	.2640	.1320	.0388	.0660	.3607	.1072	36
.190	.3040	.1520	.0446	.0760	.4153	.1235	32
.215	.3440	.1720	.0505	.0860	.4700	.1397	28
.240	.3840	.1920	.0564	.0960	.5246	.1560	24
.250	.4000	.2000	.0587	.1000	.5465	.1625	24
.270	.4320	.2160	.0634	.1080	.5902	.1755	22
.320	.5120	.2560	.0752	.1280	.6995	.2080	20
.375	.6000	.3000	.0881	.1500	.8197	.2437	16

TABLE VI. FLAT FILLISTER HEAD SCREWS.

A = Diameter of Body.
$B = 1.6A$ = Diameter of Head.
$K = 0.65A$ = Thickness of Head.
$D = 0.235A$ = Width of Slot
$E = 0.5K = 0.325A$ = Depth of Slot.



A	B	K	D	E	Threads per Inch.
.070	.1120	.0455	.0164	.0227	72
.085	.1360	.0552	.0200	.0276	64
.100	.1600	.0650	.0235	.0325	56
.110	.1760	.0715	.0258	.0357	48
.125	.2000	.0812	.0294	.0406	44
.140	.2240	.0910	.0329	.0455	40
.165	.2640	.1072	.0388	.0536	36
.190	.3040	.1235	.0446	.0617	32
.215	.3440	.1397	.0505	.0698	28
.240	.3840	.1560	.0564	.0780	24
.250	.4000	.1625	.0587	.0812	24
.270	.4320	.1755	.0634	.0877	22
.320	.5120	.2080	.0752	.1040	20
.375	.6000	.2437	.0881	.1218	16

The diameters at the bottom of the thread and in the angle at the pitch line, are given in columns 2 and 3, Table II., as also the excess of pitch diameter over that of the basic standard, in column 4.

Each standard for tap gauges to have the diameter, number of threads per inch and "M. S. Standard Tap" plainly stamped thereon, as shown in Fig. 3.

Standard reference thread gauges for screws and taps should be used *only* for comparative calibration in making working gauges for such screws and taps, and to detect by such measurement the wear of the working gauges in actual service.

Working Gauges for Screws and Taps.—The working gauges for screws should be made of unhardened steel, and be exact duplicates of the standard reference thread gauges for screws, in external diameter, in diameter at the bottom of the thread, in pitch and in diameter measured in the angle of the thread; each working gauge for screws to have the diameter, number of threads per inch and "M. Screw" plainly stamped thereon.

For inspection of screws, your committee recommends the use of templet thread gauges, made of steel, hardened, double end, plus and minus limits respectively, the holes being tapped to represent accurately the limits for screws recommended in the report. The thickness of these templet thread gauges for each size screw is given and is designed to admit at the maximum end all screws that are within the limits, and to reject all that are larger, while screws smaller than the minus end of the templet gauge are thus shown to be less in diameter than is specified by the minimum limit recommended by your committee.

The working gauges for taps should also be made of unhardened steel, and to be exact duplicates of the standard reference thread gauges for taps, in external diameter, in diameter at the bottom of the thread, in pitch and in diameter measured in the angle of the thread; each working gauge to have the diameter, number of threads per inch and "M. S. Tap" plainly marked upon it.

The handles of all working gauges to be of a form easily distinguished from that of the reference gauges.

Proportions for Machine Screw Heads.—In Tables III., IV., V. and VI. are details of standard proportions for round head, flat fillister head, oval fillister head and flat head machine screws. These specifications are all based upon the diameter of the screw, thus reducing the calculations to their simplest forms.

The screws considered by the committee have been confined to those used in great quantities by large manufacturers and are the class of production by machine screw manufacturers which are made from screw gauge wire and having the heads formed by pressure. These are, therefore, known as press-head screws. They differ accordingly from those made by milling operation from stock of the nominal head diameters. The latter forms a comparatively small proportion of the total production of so-called machine screws, and while in the aggregate are also largely used, are in many cases made to suit the requirements of the various manufacturers of machinery and machine tools, many of these being larger in body diameter than those which the committee was asked to consider. If the latter class of screws are to be standardized, a special committee might properly undertake this, and thus supplement the work already accomplished by the present committee.

* * *

Don't forget that the rest of an emery wheel should never be allowed to stand more than one-sixteenth of an inch from the wheel, and sometimes it should be even much closer.

SPECIAL BORING RIG.

A positive pressure rotary blower is used by the American Gas Furnace Co. to supply the air blast for the gas burners of their furnaces. The casing for this blower is cylindrical in shape but must have an elliptical instead of a cylindrical bore, because of the peculiar construction adopted for the runner of the blower. The boring and facing rig shown in the accompanying illustration is used for machining this casing. The rig is mounted in an ordinary engine lathe as in Fig. 1, the bar being driven by a flange bolted to the faceplate of the lathe, while the tail-stock end is supported by a rocker, *R*, pivoted to an arm attached to the tail-stock and kept in place by the tail-stock spindle, which bears against the rocker and forces it tightly against the end of the bar. In Fig. 2 the boring of the blower casing is shown in progress. In this illustration *A* is the boring bar, *B* the cutter head, and *C* and *D* faceplates carrying the cutters used for facing the two ends of the casing. The boring bar, *A*, has a longitudinal hole bored through it in which the shaft, *F*, is a running fit. The outer end of this shaft is squared to fit a square socket in the rocker *R*, and is thus kept from turning while the bar itself, which is driven and held in place by the lathe face-plate, rotates on the central shaft *F*. The right-hand end of shaft *F* carries a cam, against which bear the inner ends of two tool slides, one of which is shown at *S*. These slides are held against the cam face by the springs, *E E*, the springs being connected by two short bars which bear against pins attached to the cutter slides, *S*, and extending through slots in the cutter head. As the bar rotates, the tool slides move in or out according to the inclination of the cam face and the bore of the casing is thus made to deviate from a true cylinder the required amount. After the casing is bored it is then faced by moving up the two faceplates as shown in Fig. 1, until the

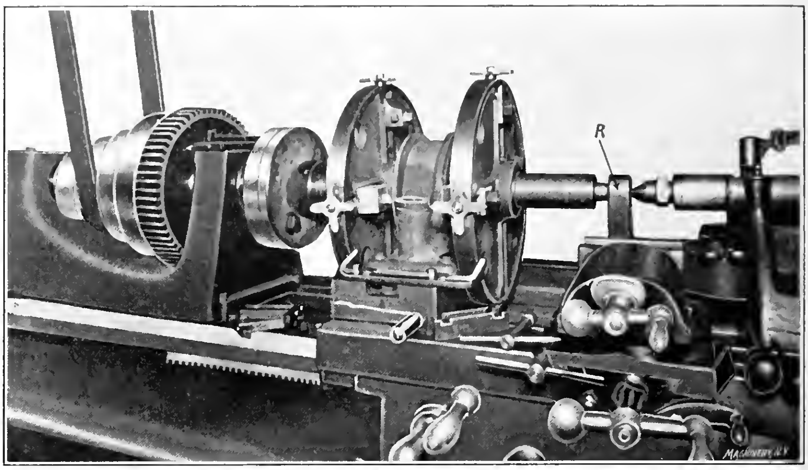


Fig. 1. Special Boring Rig for Finishing Elliptical Blower Casings.

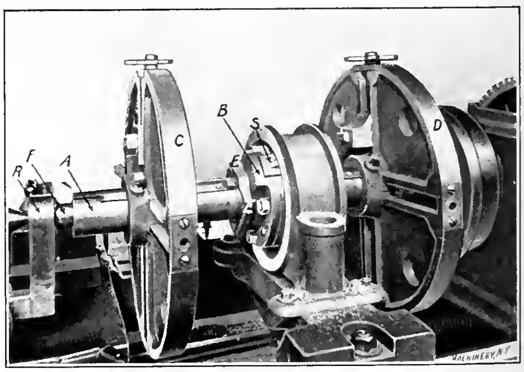


Fig. 2. Rear View of Boring Rig.

cutters inserted in the tool blocks are the required distance apart and are located correctly in respect to casting. There are two sets of cutters used, one set leading the other one and roughing out the casting, after which the second set takes the finishing cut. The usual star feed is employed for these cutters, projecting pieces being clamped to the lathe carriage, against which the arms of the star wheels strike at each revolution.

* * *

AN ENGINEER'S COMMENTARY ON HIS OWN WORK.

No man has been more closely identified with the important engineering work of California and the Pacific Slope than Mr. George W. Dickie, the author of the interesting biographical article upon W. R. Eckart, the veteran mechanic and engineer, which we publish this month. Mr. Dickie's life work has been upon the Pacific Slope and mainly in connection with the Union Iron Works of San Francisco. The success of this firm in shipbuilding and marine engineering is due largely to his foresight and enterprise and the support accorded him by influential friends in the business world. In 1881 he saw the necessity for some concern near San Francisco to equip for steel shipbuilding and repairing, and as a result of his enthusiasm and persistent efforts the new Union Iron Works were founded through the consolidation of interests supporting Mr. Dickie with the engineering firm of Prescott, Scott & Co. The new plant was located on a large tract of land at the Potrero and was adapted in every way to the needs of the shipping interests of the Pacific and of San Francisco harbor. Four or five years after the works were established the new navy began to take definite shape and twenty naval vessels have since been built there for the United States government. An average of about 3,000 men have been employed.

Three years ago the Union Iron Works were absorbed by the United States Shipbuilding Co. and the original owners disposed of their interests, Mr. Dickie retiring from the management. The best years of his professional life, however, were devotedly given to the important and successful work of this company; and this will be the great achievement of his career, however important his accomplishments in years to come.

In a presidential address given last December before the Technical Society of the Pacific Slope, Mr. Dickie spoke in a reminiscent way of his engineering experiences and particularly of his years of labor for the upbuilding of the shipping industry through the establishment and maintenance of the Union Iron Works. He added, however, a thoughtful commentary upon his long connection with this firm, which deserves to be read by every professional engineer. That the life of the engineer must be a strenuous one, self-contained and perhaps narrow, is all too true. Happy will be the man if, in his younger years, he trains himself to heed the lesson implied or expressed in this part of Mr. Dickie's address, which we print below.

"There is a condition that the technical man who labors long in one line of work is very apt to fall into, and which my present experience enables me to speak knowingly upon; that is where a man practically loses himself and is lost also to others in his work. For 22 years I had given myself up entirely to the work as I found it at the Union Iron Works, going from my home every day direct to the works at Potrero; thus I was never seen in the city in the daytime, and those who knew me as a familiar business figure in the main business streets of San Francisco at first missed me, then gradually forgot me, except as they heard from time to time what was going on at the works. When I had to begin again this year to look for the people who had been my friends so many years ago I found myself in a strange city and among people who hardly remembered the friends I was seeking for, and while many knew my name and something of my work and reputation, yet I have lost my hold on the active men of to-day because I had lost myself and all my friends in the deep grave I had dug for myself in the Potrero. We want to love our work and put all our heart and soul into it, but we must not allow ourselves to be utterly lost in it, for I am finding that after being buried for 22 years in a comfortable shipbuilding and engineering grave, the necessary resurrection is a sort of a Rip Van Winkle return to places where I have long been forgotten.

"It is one of the evils of our profession that he who is able to accomplish anything worth while in it runs the risk of losing himself entirely in the effort. This is partly the result of the technical education that engineers receive, which absorbs much of the time usually devoted by young men in mercantile pursuits to social intercourse. In early life the engineer gets entirely absorbed in his profession, the very language of which is an unknown tongue except to his professional friends. The technical man gradually becomes self-constrained; he is not understood in the society in which he should move, so, late in life, when he needs companionship other than that of the shop, and tries to get into the place in life that he should have always occupied, he finds that no place has been reserved for him and that he must either go back to his old grave that fitted him so well, or industrially set about digging a new grave, probably to die in the effort.

"It is this intense struggle that never ends with the engineer if he is to keep abreast with the progress in engineering science, that renders him such a dreary neighbor and chills the social atmosphere all about him; nor do I see any salvation unless he is willing in early life to cultivate more than he ever has done the social habit, and to be able to take delight in the beautiful things around him, to see more in a waterfall than so many horse-power, to be intimate with the things people generally like to see and hear about. We boast very much about the vast achievements of modern engineering, and rightly, too, but it might not be easy to sum up what the development of engineering has added to the sum total of human happiness.

"When I look back upon my own engineering experiences I do not find anything that looks now very noble or really worth a man's putting his life into, although a lot of it may have been useful enough at the time. I see only a confused mass of iron beams and steel shafts, hear only the din of wheels and the roar of steam, with here and there a little gleam of something better, and when my memory catches these little bright spots in the picture I find that these were the days when I escaped from engineering and with the wife of my youth got away from the clang and the clamor of these man-made forces, and for a little while crept into the bosom of mother nature, listened to her soothing music, heard the beating of her great heart and rested happy in the though that I was, after all, one of her children who had tired himself out in fighting her forces. It is a comfort to be able to recall the times and places wherein I came nearest to being happy and to know that these spots are never closed to those tired of the struggle with stubborn circumstances, and it may be that the next hole I creep into will be among the beautiful Santa Cruz mountains. No, it will not be a hole, but "Loma Linda," the hill beautiful, and to such a place, if I get there, it will be my delight to draw many a weary technical that he may learn his child lesson that life is vastly more than an engineering problem."

[Loma Linda is a beautiful country place of 200 acres owned by Mr. Dickie in the Santa Cruz Mountains. The house was destroyed in the great earthquake.—Editor.]

* * *

The business of Westinghouse, Church, Kerr & Co. of New York has been purchased by Kean, Van Cortlandt & Co., and will be reorganized. The president of the new concern will be John F. Wallace, the Panama engineer whose resignation from the commission a few months ago caused such a stir. The great development of engineering work, particularly the terminals of important railroads, has made necessary a more powerful construction company than the old firm of Westinghouse, Church, Kerr & Co., or in other words one having greater capital. The new company, it is stated, will have a capital of \$12,000,000 and will start business with cash resources of \$7,000,000. The Westinghouse interests will be represented by George Westinghouse, who will be on the board of directors.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1906.

PAID CIRCULATION FOR MAY, 1906,—22,624 COPIES.

MACHINERY is published in four editions. The practical work of the shop, s thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE WELFARE WORK OF THE NATIONAL CIVIC FEDERATION.

The interesting photographs of the Homestead, Pa., Club, published in the Engineering edition for last month, were furnished through the courtesy of the Welfare Department of the National Civic Federation, New York city.

The Welfare Department now has a membership of 200 employers, organized for the purpose of demonstrating what can be done to ameliorate the unsatisfactory conditions under which the employees frequently work or live. Conferences are held in different sections of the country, where experiences related by Welfare workers inevitably lead other business men to look within their own plants and adopt such features there as are applicable under the local conditions existing.

The first and most important step in any well-organized effort in this direction is to provide sanitary work places. This includes systems for supplying pure drinking water; for ventilation, including the cooling of overheated rooms and devices for exhausting dust and removing gases; for adequately lighting workrooms; for placing protectors about dangerous machinery; wash rooms with hot and cold water; shower baths for molders; emergency equipment; locker rooms; seats for women; lunchrooms, etc.

Next, after these conditions have been made as good as possible, it is feasible in many cases to go a step further and furnish facilities for recreation and education, such as club rooms, facilities for outings, night classes, etc. We are of the opinion, however, and experience in many cases bears out this view, that this last step is not always a wise one to take and unless made with a full understanding of the conditions and in entirely the right spirit it may lead to more dissatisfaction among employees than can be compensated for by the sum total of the benefits to be derived therefrom. It is well, therefore, that there is an association to assist manufacturers who are desirous of entering into welfare work, by giving them the benefits of the experience of others who have been successful and advising with them as to the proper course to be followed under the conditions which exist in any case.

* * *

Some trouble has been reported by machine tool builders who have used motor drives with the motors mounted at or near the tops of the frames of the tools, the trouble resulting from vibration due to the armature being out of balance. However perfectly an armature may be balanced when it leaves the factory it may be thrown out at any time by overheating the motor, and it does not seem in the line of good design to mount a motor on top of the frame of a milling machine or on top of the head stock of a lathe, for example, when every precaution has been taken to produce a machine tool within extremely fine limits of accuracy. It is certainly not possible to do a fine job of tool work on a lathe in constant vibration, however accurately the spindle and ways may be aligned. The tendency now is to mount motors on the base of the machine near the floor, or even on the floor itself. The all-gear drive for machine tools lends itself admirably to this arrangement, for it can be designed with the single driving pulley overhanging, allowing a clear way for the belt connection between this pulley and the pulley on the motor. One of the best examples of this arrangement is in the Flat Turret lathe, which has the overhanging pulley, and is easily driven by a motor on the floor under the head end of the lathe.

* * *

TWO GALLON AUTOMOBILE CONTEST.

Automobile contests have usually been conducted with no more important aim than to gratify the desires of a certain few of the sporting fraternity, who class sport and foolhardy exhibitions, like the race at Ormond Beach last April, as one and the same thing. The Automobile Club of America, however, should be given the credit for instituting an efficiency contest last month which must be of interest to everybody who has anything to do with automobiles, be he manufacturer or user. This is the two-gallon contest over a course starting at 57th St., New York, and extending north and east along the Connecticut shore through Stamford and New Haven. Each car started with exactly two gallons of gasoline in its tank and was to travel as far as possible with this small fuel supply. It was a handicap trial, the basis of comparison being a car with four or more cylinders. Allowances were made either in favor of or against other cars of different construction or weight to make the score fair to all. The distance traveled and the weight of the car, with a handicap of 800 pounds added, were used in figuring the score; but allowances were made to one- and two-cylinder cars, because of their supposed inferior efficiency. The first prize went to a four-cylinder Franklin of 12-horsepower, which covered 87 miles. Another Franklin car, however, of the same type, completed only 58.4 miles, indicating that the skill of the chauffer as an engineer had almost as much to do with the result as the design of the machine itself. In fact, while this trial had nothing of the spectacular about it, and would not ordinarily be classed with the Ormond Beach race as a sporting event, it was really a more complete test of the ability of the man driving the machine than was the latter.

While the two-gallon efficiency test was a move in the right direction, no results of great value to manufacturers are likely to be obtained except by means of laboratory tests of automobiles. It is a fundamental principle that no satisfactory results are ever reached by testing two elements of an apparatus at the same time. To really find out anything about the performance of an automobile we should know first what the rate of consumption of the engine is and second what is the efficiency of the transmitting mechanism. Such results, taken in connection with road trials would give manufacturers important data to base their work upon.

* * *

It is a disappointment to the advocates of concrete construction that there were no buildings of reinforced concrete in San Francisco by which the merits of this type of building for localities subject to earthquakes could be judged. The nearest to this type of construction, in principle, though not in form, was the Palace Hotel, a building with solid brick walls tied together by a large number of intersecting partition walls, which were also of solid masonry. This building had been built upon honor, with a good quality of cement or mortar and was as nearly a monolithic structure as could be produced without the use of reinforcing rods such as employed in concrete work. The Palace Hotel withstood the shock well, although other masonry buildings constructed in an inferior manner crumbled under the tremor. It seems reasonably certain that reinforced concrete will be used extensively in San Francisco for rebuilding the new city.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

In the November and January issues mention was made of the metal tantalum which is being developed commercially by the Siemens & Halske Co. of Berlin, Germany. Tantalum has characteristics that should make it very valuable for certain tools and purposes where extreme hardness, toughness and elasticity are requisites. As an example its use for pens is said to promise the displacement of steel and gold. Tantalum pens resist the chemical action of inks to a remarkable degree and are much harder and more elastic than steel pens; they are more elastic than gold pens and of course do not have to be tipped with iridium as do gold pens.

A curious product is mentioned in a United States consular report from Paris, France, being called calcium steel, although it is a ceramic product; it is made by baking a paste made of finely pulverized feldspar, sand and lime mixed in certain proportions. The product, however, has remarkable qualities, being a porcelain or earthenware of great hardness and durability. It resists corrosion by acids, is a poor conductor of heat and electricity, and has a specific gravity of only 3.3. Although hard, it is very tough and can be machined the same as metals, being readily bored, cut, planed or polished. One of the uses for which it is expected to be valuable is for pipes and conduits of water, gas, chemicals, etc.

Few of us have adequate appreciation of the machinery in any large city or town for the distribution of food supplies. The New York *Times* says that it was noted long ago by Archbishop Whately that the provisioning of London, though a task probably beyond the ability of the greatest of commissary officers backed by the authority of the government, was daily performed perfectly and easily by utterly unknown persons, each working, as it were, independently but, of course, in harmony with the law of supply and demand. In San Francisco the demoralization of the avenues of trade by the great earthquake threw an enormous task on the improvised commissary department of feeding the hundreds of thousands of people who had lost their homes and means of subsistence. A study of the difficulties of providing for people in such a condition only brings out more prominently the fact that under normal conditions most human beings are and must be largely self-regulating in their mode of life, and the same also applies in any shop or factory. The direction of work in a shop first of all requires that the workers shall be trained so that a word or hint is sufficient for them to proceed in an orderly manner to accomplish any task. When men are not so trained it means that a boss shall stand over them who shall direct every move. That the direction of work and the accomplishment of satisfactory results by "bossing" is one of the hardest things to do will be generally acknowledged by those who have had some experience.

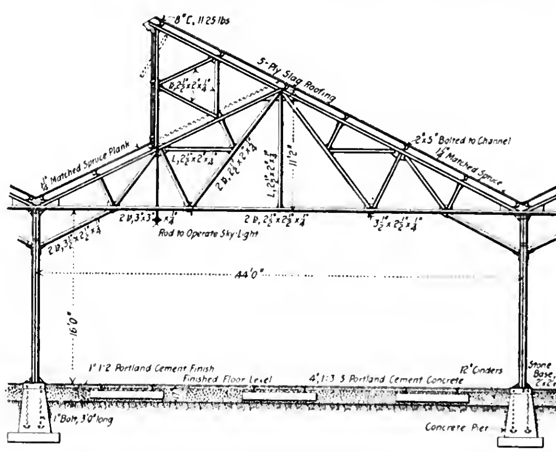
A curious effect was noticed in connection with a kinetograph view which was taken in Germany not long ago. It was obtained at the time of the visit of the King of Spain to Berlin, and represented the entrance of the procession into the city. The horse guards led off, then a line of carriages, and lastly a line of mounted cavaliers. What was surprising about this view was that while the carriages moved in the line of march as they should do, the wheels appeared to revolve slowly in the contrary direction, and thus the spectators had the impression that the vehicles were about to be dislocated and torn apart. In another view of the same scene the wheels did not turn at all, or else swayed slightly to and fro about the center. The phenomenon is easily explained, although at first it puzzled nearly everyone. To take the views we photograph the objects successively within at least one-tenth of a second, and then project them in the same order on the screen. In the case of a moving carriage wheel the rotation is suggested to the eye entirely by the displacement of the spokes. But here the kinetograph may be completely at fault. For instance, in one of the views a spoke of the wheel occupies a well-defined position. In the following views if the second, third, and fourth spokes are made to occupy exactly the place of the first in their turn, the successive images of the wheel will not differ from each other. The spectator will therefore not have the sensation of the wheel's movement. According to the relative speed of the wheel and the projection apparatus we may find that the successive spokes have a slight advance or lag relative to the position of the first one and give the illusion that the wheel is turning forward or back, as the case may be.—*English Mechanic.*

MODIFIED FORM OF SAW-TOOTH ROOF.

A modified form of saw-tooth roof is described in the *Engineering News* by M. S. Ketchum. This roof has been used for one of the shops of the Public Service Corporation of New Jersey.

The principal advantages of the modified saw-tooth roof are that it allows the use of ordinary valley gutters, and gives an opportunity to take care of the condensation on the inner surface of the glass by suspending a gutter at the bottom of the monitor leg. Snow will cause very little trouble with this roof on account of the increased depth of gutter. The modified saw-tooth roof has a greater pitch, and permits the use of a more economical truss for long spans than the common form of saw-tooth roof.

The roof is a five-ply slag roof laid on 2-inch tongued and grooved spruce sheathing, which is spiked to 2 x 5-inch spiking strips bolted to 8-inch channel purlins spaced 6 feet on



centers. The roof water is carried down 5-inch cast iron leaders attached to alternate interior columns. The sash in the vertical leg are in two rows, the upper row being hinged at their centers, thus providing ample ventilation. Condensation gutters are placed below the vertical leg (on the inside) to take the drip. The skylight area is about 20 per cent of the roof area, the window area is about 45 per cent of the outside walls; thus about 28 per cent of the entire outside surface of the building is of glass. All glazing is of ¼-inch ribbed wire glass, with the ribs placed vertical. The skylight frames and moldings are made of No. 24 galvanized iron, while the entire roof is flashed with 16-ounce copper sheets, 4 feet wide, and counter-flashed with sheet lead.

In a short article by Mr. W. S. Butcher on the photographic reproduction of blueprints in the *Engineering News* the writer says there is a growing tendency in engineering offices to invoke the aid of photography for the purpose of reducing large plans to convenient size both for filing and for use. It is generally possible to show on small reproductions all the necessary details which on a blueprint require the use of large and

cumbersome rolls or portfolios. Photography is also of use for reducing plans of various scales to a uniform scale and is desirable when making assembled drawings, or tracings. To make photographic reductions directly from blueprints is a difficult matter inasmuch as the actinic value of the light reflected from the blue and white parts of the blueprint is nearly equal, and hence a negative made from a blueprint under ordinary light conditions is entirely too faint for making prints. Some success has been attained by changing the blue to green by chemical process but it soon fades away, thus destroying the original. The described method of photographing blueprints depends upon the well-known fact that the blue background absorbs all the colors of the light coming to it but the blue rays so that if the blue rays are cut off from the source of light the blue portion will appear black. To photograph the white lines successfully when the blue rays are stopped off it is necessary to use orthochromatic or isochromatic plates which are sensitive to orange rays. The operation of taking a negative is best performed by covering a window facing the south with two or three sheets of orange colored paper in front of which the blueprint is set up and photographed in the ordinary manner. A somewhat extended exposure is required amounting in most cases from 10 to 15 minutes, the time of course depending upon the intensity of the light.

REMARKABLE LOGARITHMIC TABLES.*

CALCULATED AND PRINTED BY MACHINERY.

There is in the Society's library a book, the peculiarity and value of which is entirely unknown to practically all of its members. Though it is printed in a foreign language, it may be used with ease or consulted by any of the members, it being a TABLE OF LOGARITHMS.

To demonstrate the above quoted "peculiarity and value" of this work, the undersigned has made a translation of the preface to it, which explains its manner of computation and make-up, etc., and which is herewith respectfully submitted for the information of the Society. The tables are arranged on the same principles as the well known "Vega's Tables."

Respectfully,

G. A. M. LILJENCRANTZ, M. W. S. E.

The Preface.

It is a well known fact to every mathematician that the usual method employed for obtaining logarithm tables does not offer sufficient guarantee against misprints. The only means of making such tables fully reliable is undoubtedly the use, for their calculation, of an apparatus which accomplishes both the calculation and the printing or stereotyping of the procured quantities.

The proofreading, upon which the reliability almost exclusively depends, will then be reduced to a mere trifle, and becomes exceedingly easy, for the only proofreading then required is that concerning the difference between the trigonometrical logarithms, for the calculation of which the machine will, as may be easily conceived, serve as a "setting machine."

This circumstance suggested to me, as much as twelve years ago, the idea of publishing logarithm tables, by aid of the calculation machine previously invented by me.

The accomplishment of such a work, however, would have involved far greater expenditures than my personal means permitted, and my plan would probably never have been executed had not our present King, His Majesty Oscar II, then Duke of Oestgothland, taken the initiative to and supported the formation of the so-called: "Wiborg's Table Stock-Company (Wiborgska Tabell Actie Bolaget), in which the most prominent magnates of Sweden took shares.

For the liberal generosity of this Association, through which the publishing of these tables has been rendered possible, I wish to extend my warmest gratitude.

According to the plan devised by me, the machine was to print the computed quantities in lead, from which were to be made galvanoplastic reprints in copper, from which the desired tables should then be printed.

The realization of this plan was, however, found to be combined with far greater difficulties than had been anticipated. Much time was consumed in overcoming these difficulties; hence the work has not been completed until now, after years of struggle.

It is presented to the public under the conviction that the mathematician will consider the greater reliability it offers over tables produced in the usual manner, as fully compensating for the lack of ornamentation in typographical respect, that others may possess as compared with these "machine-made" tables. A work of attractive appearance, typographically, is much easier to produce in the usual manner than by a calculation machine. The difficulties in forming perfectly straight lines by the machine printing are naturally very great. The first one is to get the figures engraved with minute exactness in the different printing wheels. This successfully done, it may happen that in the hardening of the wheels some of these may warp more or less. The least wear, furthermore, tends to make the figures more or less uneven. A different density of the lead, or the material in which the machine is made to print, or uneven pressure, causes also a crowding, which has a bad effect on the regularity of the lines. No attempt to compete by this method of printing with that usually employed, as regards the typographical appearance, can therefore be considered.

I hope, however, that to anyone who buys the tables with the object of *using them*, the work will prove satisfactory.

Concerning the arrangements of the tables, these are in the main in accordance with those of Bremiker and Dupuis.

Stockholm, in November, 1875. M. WIBORG.

* From the proceedings of the Western Society of Engineers.

DANGER OF A SHORTAGE IN IRON.

Consul-General Mason, of Paris, has gathered statistics upon the world's supply of coal and iron. While there has been much talk, at one time or another, about the exhaustion of the anthracite coal supply, it will be a surprise to many to learn that the danger in a shortage of iron ore is even more imminent. The world has only 10,000,000,000 tons of iron ore available. Of these, Germany has twice as many tons as the United States. Russia and France each has 400,000,000 tons more than this country. Our annual consumption is placed at 35,000,000, which is more than a third of the world's total consumption.

Several months ago the Parliament of Sweden, then in session, adopted a resolution, calling for a report showing the extent of the known deposits of iron in Sweden and other countries, and the rate at which such deposits are being consumed by the steadily expanding iron and steel industries of the world. The report was made by the chief of the Swedish geological survey, together with comments by several other experts. While there has been some dissent as to the exactness of certain details, the report has been accepted as substantially accurate.

Condensed to their smallest compass the statistics of the report give the following comparative exhibit of the whole known amount of workable iron ore yet available in the several iron-producing countries. The present annual output of ore, and the amount of ore actually consumed by each, is as follows, in tons:

Country.	Workable Deposits.	Annual Output.	Annual Consumption.
United States	1,100,000,000	35,000,000	35,000,000
Great Britain	1,000,000,000	14,000,000	20,000,000
Germany	2,200,000,000	21,000,000	24,000,000
Spain	500,000,000	8,000,000	1,000,000
Russia and Finland.	1,500,000,000	4,000,000	6,000,000
France	1,500,000,000	6,000,000	8,000,000
Sweden	1,000,000,000	4,000,000	1,000,000
Austria-Hungary ...	1,200,000,000	3,000,000	4,000,000
Other countries	....	5,000,000	1,000,000
Total	10,000,000,000	100,000,000	100,000,000

While it is probable that the foregoing statement does not take into adequate account the undeveloped ore deposits in Utah and Alabama, its teachings are neverthelss obvious. Of the world's workable iron-ore deposits, as at present known, the United States possesses only about one-ninth, and at the present rate of consumption the entire supply will be exhausted within the present century.

It is well known that the high-class ores of the lake district in America will, at the present rate of consumption, be ex-

hausted within less than fifty years. The Mesaba deposits, with the present annual output of 12,000,000 tons or thereabouts, will not outlast twenty-five years, and it requires only a simple calculation to demonstrate that a continued yearly consumption of 35,000,000 tons of ore by the iron and steel industries of the United States will, within the lifetime of many persons now living, eat away entirely the 1,100,000,000 tons which, according to the report above cited, constitute our country's entire workable supply as at present known. Inasmuch, therefore, as the United States possesses but about one-ninth of the world's ore deposit and yet consumes more than one-third of the total annual output from all countries, the conclusion is direct and unavoidable that the future economic policy of American iron masters should be to secure, by all practical means, the largest possible ore supply from the mines of other countries. How can this be most economically and effectively accomplished?

The problem is largely one of transportation in which the item of marine freight rates plays a dominant part. An economic long-distance ocean rate for heavy, low-class merchandise, involves necessarily two conditions, viz., vessels specially adapted to the trade, and return freights that will bear an equal or higher charge for transportation. The ship that brings ore from Spain, Sweden, and other European countries to the United States, must have each trip an eastward-bound cargo that will be more than ballast and yield a regular and definite profit. There is but one material which will meet the requirements of the case, and that is coal.

It is in respect to quantity and quality of coal supply that the advantage of North America over European countries is decisive and overwhelming. Whatever may be the facts concerning ores, the known coal measures of the United States render their fuel supply secure, abundant, and of excellent quality for centuries to come. There are hundreds of thousands of acres of gas and coking coals of high quality in the Appalachian region—to say nothing of other fields—which have as yet been hardly scratched by the pick and drill of the miner. New coal deposits of greater or less extent and value are being discovered from year to year. With what is now known the present enormous annual output of 280,000,000 tons of bituminous coal can be maintained for hundreds of years without exhausting the available supply. In Europe, on the contrary, the years of adequate coal provision are definitely numbered. In England experts estimate the duration of the workable coal measures to be from sixty to one hundred years. Germany has a somewhat longer lease of industrial life dependent on coal supply, but already the subject is so acute that a heavy contract for the delivery of German coal to France, for iron and steel works, is understood to have been canceled recently at heavy loss to the sellers, because, as it is definitely understood, the Imperial government objected to the depletion of the national coal supply for the benefit of neighboring countries. France has native coal for a generation or more, but the mines are deepening, the cost of production is gradually increasing, and economists are looking with growing apprehension to the future. Twenty-five or at most thirty years hence, the question of an adequate fuel supply will be a serious problem for France.

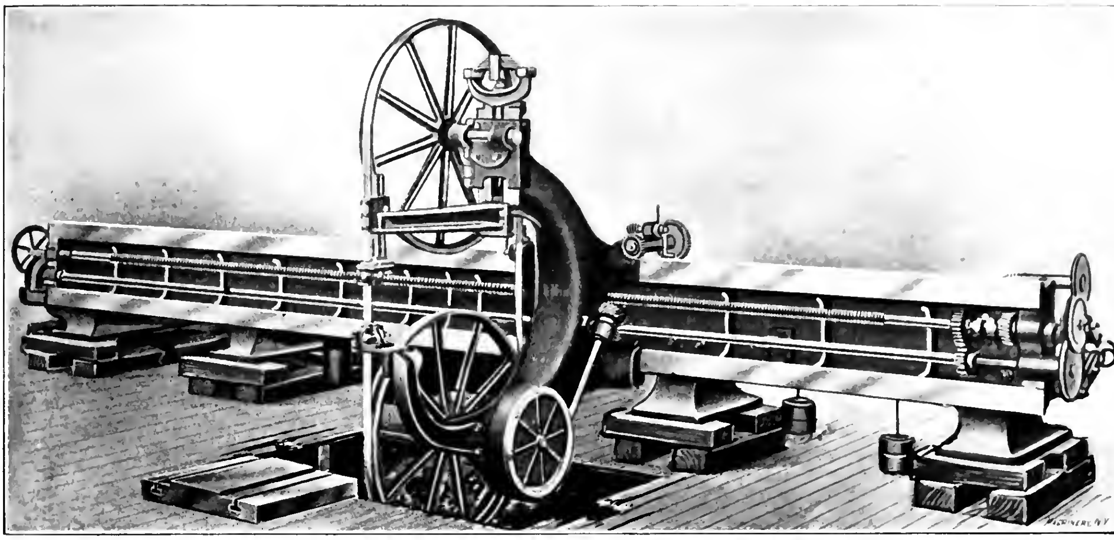


Fig. 1. Band Saw for Trimming Armor Plate.

BAND SAW FOR ARMOR PLATE.

The accompanying half-tone and line-cut illustrations, taken from *Engineering*, show an interesting band-saw machine tool for sawing armor plate, which was designed by Mr. L. Schechter and built at the Kharkow Locomotive & Engineering Works, South Russia. The half-tone shows the band-saw head and the supporting rail, but not the work tables or the bed plate supporting them. In the setting of the machine a pit is provided for the traverse clearance of the lower half of the bottom pulley, which part is below the floor level. The cross section, Fig. 2, shows these clearly, and Figs. 3 and 4 give

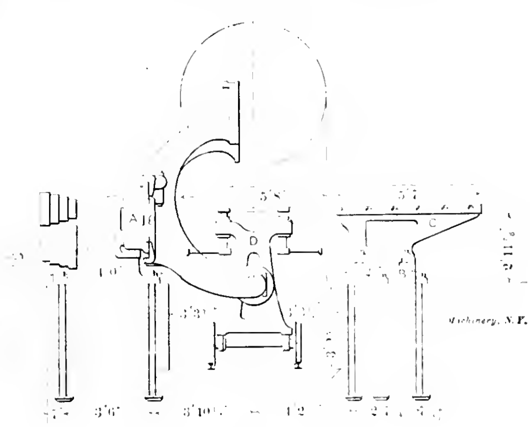


Fig. 2. Cross-section of Machine

the end and side elevations together with some dimensions. The plate to be trimmed or sawed in two is laid upon *C*, where it remains stationary, being clamped to the table. The band-saw head traverses on the rail *A*, power being communicated to it from a 5 H. P. constant-speed electric motor through the splined shaft *D*, while feed motion to the head is transmitted through the screw shaft *C*; the rate of feed is varied by the well-known Sellers friction disks, shown at the right. The machine has a capacity for cutting armor or other plate up to a thickness of 5.9 inches, a width of 5 feet 7 inches, and

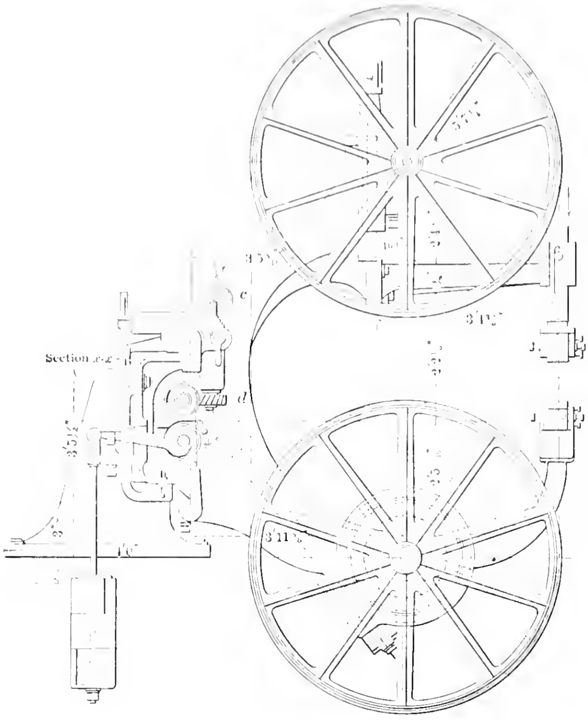


Fig. 3. End View of Traveling Saw Frame

a length of 27 feet 10 inches at one setting. The bed-plate *B* supporting the tables is 31 feet 2 inches in length and on it are bolted six tables, each 21⅝ inches in width. The plate to be sawed is clamped on the tables while the portion to be cut off rests on the movable supports *D*. The band-saw pulleys are each 5 feet 7¾ inches diameter with a face for a 4-inch saw; power is communicated through the lower pulley from the motor, which runs at the constant speed of 1,120 revolutions per minute. The circumferential cutting speeds at which the saw is run are about 12¼, 18⅛, 26, and 36¼ inches per second, the changes being made on a four-step cone pulley. When used for cutting armor, say 5.9 inches thick, the cutting speed of the saw is about 18¼ inches per second. The feed motion may be varied within the limits of 0.08 to 3.03 inches per minute.

THE DEVELOPMENT OF THE GAS ENGINE.

From a Paper by C. E. Sargent upon "The Prime Mover of the Future," before the Western Society of Engineers, December 6, 1905.

The economy of the internal combustion engine has been recognized from its inception. Both the theoretical and practical efficiency of this type of prime mover is from two to five times greater than that of the average externally fired heat engine. The smallest gas engines have a thermal efficiency from 20 to 24 per cent, while the largest steam engine, with all modern refinements known to the art, does remarkably well to turn into work 12 per cent of the heat supplied to the furnace under normal conditions. For well known reasons the thermal efficiency of steam engines increases with the cylinder volume, but although this increased efficiency is not so apparent in internal combustion engines, a comparison of the thermal efficiency of an ordinary gas engine with the largest and most economical engine propelled by steam, while perfectly fair to both types, still shows 100 per cent in favor of the internally fired prime mover.

A plant recently tested by the writer in which producer gas from anthracite culm was used, showed the cost of fuel per horse power hour to be about 1.5 mills. By selling the by-products of the bituminous gas producers at the market price, a recent writer in *Power* claims that power from gas engines can be generated 14 per cent cheaper than from water falls.

As the efficiency of the steam plant depends largely on the rapid transmission of heat through boiler walls, and the efficiency of the gas engine on our ability to prevent heat from passing through, the gas engine cylinder can be very much thicker and stronger than the boiler shell, and while the pressure during rapid combustion exceeds the pressure usually carried in the steam boiler, accidents from ex-

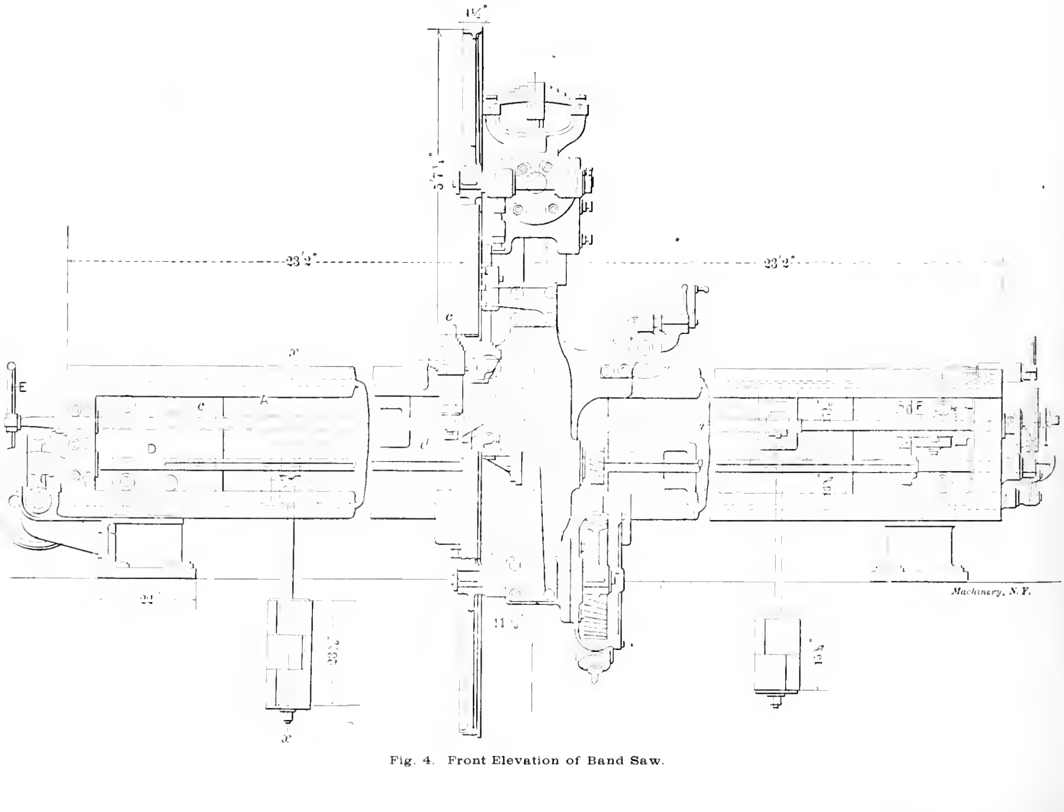


Fig. 4. Front Elevation of Band Saw.

ploding cylinders are almost unknown, and accidental gas explosions doing considerable damage, very rare.

The first cost of a large gas engine plant, including producers, coal handling apparatus, piping, scrubbers, cleaners, building, compressor and engines is not far from that of a steam plant complete, including boilers, engines, pumps, condensers, chimney, piping and all accessories, so we can assume the first cost the same in each case. Since great pressures are not maintained in gas engine installations as they are in boiler plants, the depreciation from internal strains and corrosion should be considerably less. Gas engines do not wear out any quicker nor do they need any more repairs than steam engines. Gas producers are long lived, the apparatus requiring but little attention and few repairs. The Erie R. R. Co. have had two 200 H. P. producers in operation at Jersey City for seven years and the fire in one has never been out. Imagine the condition of a boiler after such a run. Although the cost of operation including oil, waste, packing, purgers and labor would no doubt be less for the gas engine installation than for steam, no claims for savings are made on this account.

Stand by losses are much less in the internal combustion engine plant if run intermittently or if part of the equipment is held in reserve for immediate service. The gas holder with the producer provides for the peak of the load even though the producer is run at a uniform rate. With sufficient capacity of holder the gas producer may be run with a uniform output for every hour out of 24 though the engine load vary through the widest possible range, and running under such conditions, there are practically no losses from radiation or leakage, as would exist in a boiler plant under pressure.

The California Gas and Electric Corporation, which normally gets its power from waterfalls two hundred miles away, carries a gasometer full of coal gas always in reserve for use in gas engine units, should the long distance power fail.

When compressed air is available, and all large units use this medium, gas engines of any size can be started and can take the full load in two minutes' time as no warming up or cylinder draining is necessary. The waste heat, about 70 per cent of the heat supplied, can be used for heating and a higher temperature can be maintained than with the heat from a steam engine exhaust. If the internal combustion engine has so many advantages over steam, why, then, has it not had greater development? Why are we not using gas engines in our large power plants? Why are we using 40,000 B. T. U. instead of 10,000 B. T. U. in generating a brake horse power? Why are we burning 400 cubic feet of waste gases under our boilers to evaporate sufficient water for a horse power hour when 100 cubic feet burned behind the piston would do the same work? Simply because the American manufacturers have not kept pace with the development of the gas engine as a prime mover.

Five years ago when Mr. Henry Wehrum, who has probably done more to introduce the gas engine for power for steel mill work in the United States than any other man, wanted one and two thousand horse power gas engines for the Lackawanna Steel Company's plant at Buffalo, there was practically but one engine obtainable and that of foreign make. A few months ago when the Carnegie Company wanted engines of the same size for the Edgar Thomson Works, twelve proposals were received from American manufacturers.

While the Europeans in order to manufacture at a profit, on account of the high price of fuel have been driven to the gas engine for power, the largest internal combustion engines ever made are of home product. It is said that a representative of the United States Steel Corporation went to Europe to investigate the gas engine for steel mill work. After visiting several plants which were in successful operation, he said that they worked very nicely for small engines, but he would like to see the largest engine ever built, whereupon he was advised to go home and see the 4,500 H. P. gas engine built by the Snow Steam Pump Works. This company has running and is having installed 25 internal combustion engines having a total capacity of 48,000 H. P. The largest engine ever built, a twin tandem 52 inches by 60 inches, 5,400 B. H. P., is now being erected for the California Gas & Electric Corporation, and three others of the same size will follow.

The De La Vergne Machine Company have built nearly 50,000 H. P. of two and four cycle gas engines and have 40,000 H. P. installed in the Lackawanna Steel plant at Buffalo, N. Y.

The Westinghouse Company is installing engines of 2,000 H. P. and at least half a dozen manufacturers in the United States will take contracts for any size.

Such has been the growth of the internal combustion engine since 1900, yet the beginning of the present gas engine era, in the United States at least, dates from the expiration in 1890 of the fundamental four cycle patent of Dr. Otto. Of course there were several attempts to make commercial gas engines of the six-cycle or two cycle type before this time, but with the exception of a few two-cycle marine engines and the imported Koerting, the other attempts have been abandoned. It would seem that the owners of so valuable a patent as that of the Otto cycle, while the protection lasted, would have used every effort to develop a large and remunerative business, but there are several reasons why more progress was not made by the owners of the American rights, while they enjoyed the exclusive monopoly of the only successful gas engine cycle at that time.

In the first place, the firm itself was impregnated with a certain amount of Teutonic conservatism, which prevented the progress one would expect from a live American manufacturer; even the directions for using the Otto gas engine, a 16-page pamphlet, were sold for 25 cents a copy. Then again, only illuminating gas, which in those days cost more money than it does now, was available for fuel, and with a very high-priced engine, upon which the general public looked with more or less suspicion, the advantages of the internal combustion engine over steam engines were questioned. But when it was found that the by-product of the refinery, gasoline and distillate, were available for fuel, and the fundamental patent had expired, the era of the internal combustion engine began to dawn. Manufacturers who had been experimenting with engines of the two-cycle and Brayton type, began to build engines of the Otto cycle, and to-day there are upwards of five hundred manufacturers of gas engines in the United States alone.

The largest gas engine exhibited at the World's Columbian Exposition, thirteen years ago, was of only 35 H. P.

The opening of natural gas wells and the invention of practical producers have provided a cheap fuel for the internal combustion engine, and the utilization of a by-product of the coke ovens and blast furnaces—an excellent gas engine fuel, have given the present impetus to gas engine manufacturers.

While the work done by the gas engine required no niceties of regulation, like driving a dynamo or textile machinery, a single cylinder engine with an impetus or blow when loaded every second revolution and when running light once in a while, was a satisfactory source of power, but with the necessity of a better turning moment and better governing, more cylinders were added, thereby increasing the impulses per revolution, or the admission was throttled, reducing instead of the number of explosions, the mean effective pressure of each impulse.

As the highest possible compression without danger of premature ignition is conducive to the highest efficiency, the hit-and-miss method of governing is a more economical method than reducing the charge, but the advisability of a close regulation and uniform rotation makes the latter method imperative.

As the exhaust stroke of a four-cycle, single-acting engine has no compression to bring to rest the reciprocating parts and as a triple or quadruple crank is not only expensive to build and maintain in alignment, but as the work on one crank must be transmitted through other cranks, there arose a demand, in the minds at least of engineers, for a double-acting gas engine, which, if made tandem, even with the four-cycle, would give not only an impulse for every stroke, or twice during a revolution, but the reciprocating parts would be brought to rest by the compression indigenous to each stroke.

A 60-H. P. engine, embodying these features, designed in 1897, was, to my knowledge, the first successful double-acting engine ever built, though Dick Kerr & Co., of Kilmarnock, Scotland, had built a few both four and six-cycle tandem engines, two of which had a brief existence in a central lighting station at the corner of Clark and Lake Streets, Chicago, in '95 or '96.

At the Paris Exposition in 1900 a 1,000 H. P. single acting single cylinder Cockerell engine was known, but the double-acting tandem engines now building by most European and many American manufacturers, were conspicuous by their absence. With a tandem construction, with a single crank we can get as many impulses as with a single steam engine, and with a twin tandem, as many impulses as with a cross compound engine. With this type approaching as it does, the steam engine design, the driving of multiphase generators in parallel is readily accomplished.

THE THEORY OF THE HATCHET PLANIMETER.

The construction and operation of the "hatchet planimeter" were described in the September issue of MACHINERY. The simplicity of the instrument, considering the comparatively complex nature of the problems it has to solve, lends considerable interest to the question of the principle on which it operates. In the following paragraphs is given an explanation based on an article on this subject which appeared in the *Revue de Mecanique*, issue of July 31, 1905. Liberties have been taken with both the translation and method of the proof.

If the stylus end of the planimeter shown in Fig. 1 be made to follow any straight or curved line, such as $T\,T$ in Fig. 2, the hatchet end will describe a curve, $M\,M$, whose character will vary with the relative positions of line $T\,T$ and the starting point of the hatchet end. Let $A\,B$ represent the location of the axis of the planimeter when the stylus has reached A, and $A'\,B'$ the corresponding location when the stylus has reached A'. $A\,B = A'\,B' = l$ on the planimeter shown in Fig. 1. Let it be required to find the area of the figure $A\,B\,B'\,A'$. This figure $A\,B\,B'\,A'$ can evidently be divided into an infinitely large number of little sectors of circles whose sides will make an infinitely small angle with each other. Assign to this angle a value $d\,\alpha$, and represent the sector by the dotted lines in Fig. 2. If a circle has a radius l, it will have an area of $\pi\,l^2$; therefore, the area of any sector of that circle whose sides make an angle $d\,\alpha$ with each other may be expressed thus:

$$\text{Area} = \frac{d\,\alpha\,\pi\,l^2}{360}.$$

Let α represent the total angular movement of the instrument in going from $A\,B$ to $A'\,B'$, or in other words, the angle $A'\,O\,A$ which would be included between $A\,B$ and $A'\,B'$ if the latter line were produced to meet the former; then, since angle α is the sum of all the little angles $d\,\alpha$, area $\dfrac{\alpha\,\pi\,l^2}{360}$ will be the sum of all the little areas $\dfrac{d\,\alpha\,\pi\,l^2}{360}$. So for any figure described as was $A\,B\,B'\,A'$,

$$\text{Area} = \frac{\alpha\,\pi\,l^2}{360}.$$

This formula is an expression of the following fact: The area swept over by the axis of a hatchet planimeter when

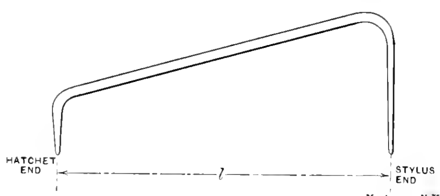


Fig. 1

moving between any two positions is equal to the area of a sector, of which the radius is the same as the length of the instrument (indicated by l in Fig. 1), and in which the angle between the sides is equal to the angular change in location between the two positions of the instrument.

The value of the area, however, may be positive or negative. If, for instance, after the planimeter has reached position $A'\,B'$, it should return to its previous position, $A\,B$, it would have swept over the included area twice, once in a positive direction and again in a negative direction, thus reducing the value of the area to zero. We may then say that the area swept by the instrument may be given a positive valuation when the angular movement is in the direction of the hands of the clock; while, if the angular movement is in the opposite direction, the surface generated may be considered in a negative sense.

Now, let us look at Fig. 3 and analyze the action of the instrument in obtaining the area of the figure $A\,F\,A'\,C$. Starting with the stylus point at C and going around the outline in the direction of the arrows, the hatchet and the instrument will trace the curve $D\,B\,B'\,D'$. When the stylus is at C, the hatchet will be at D; when the stylus is at A, the hatchet will be at B; when the stylus is at F, the hatchet will be at E; when the stylus is at A', the hatchet will be at B'; when the stylus is at C again, the hatchet will be at D'. Then $C\,D = C\,D' = l =$ the length of the instrument. There are in this traced curve two points, $B\,B'$, where the outline takes a sharp retrograde direction. These points of retrogression will take place when the instrument is in a position normal to the curve it is tracing; in the case of simple outlines, there will generally be two of these points, as is the case in Fig. 3.

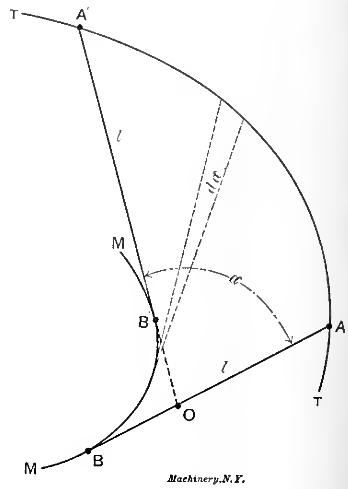


Fig. 2.

Now, in moving from C to F the instrument sweeps over the area included between curves $C\,A\,F$ and $D\,B\,E$, and the two radii $C\,D$ and $E\,F$. In going from F through A' to C again, the instrument sweeps over the area included between the curves $F\,A'\,C$ and $E\,B'\,D'$, and the two radii $E\,F$ and $C\,D'$. In the first half of the movement, the area swept over may be considered as negative. The second part of the movement from F through A' to C will generate a surface whose area has a positive value, as previously explained, since here the angular movement of the instrument is in the direction of the hands of a clock. Different portions of the area swept over by the instrument are shaded in different ways to represent the direction of rotation of the instrument and the number of times that the arm of the instrument passes that particular area. For convenience in investigating the operation, in Fig. 4 outlines are given of the various fragmentary areas which go to make up the main figure. These fragmentary areas are represented by S_1, S_2, S_3, S_4, and P, and these letters will be used to designate these areas, in finding a formula which will describe the action of the instrument. Referring to Figs. 3 and 4, by inspection we may perceive that the following expression is true:

$$P = S_3 + S_2 - S_4 - S_1. \qquad (1)$$

Let us for the time being assume that S_1 equals S_2. If this is the case, they will cancel in the preceding expression, giving us as a result

$$P = S_3 - S_4. \qquad (2)$$

If we start at C to trace the outline $C\,A\,F\,A'$ the final position of the instrument will be on the line $C\,D'$. If we swing the instrument around point C, bringing the hatchet end from point D' down to D, which was its original position, according to the analysis made in the first paragraphs, the total area swept over by the instrument will be zero, since the instrument lies in the same straight line with its starting position; the angle between its two positions will be zero, making the area swept over also zero. In expressing the complete cycle of movements as a formula, it will obviously not be necessary to include that part of the operation which involves the pass-

ing over of an area twice, if it is done at one time in a positive and at the other time in a negative direction; the two values will undoubtedly cancel each other. It will be noticed that at one place there is a small space which has been passed over three times, once in a negative and twice in a positive direction. This cancels out and gives us the equivalent of an area passed over once in a positive direction. Bearing these points in mind we may add together all the areas swept over in tracing the curve, and then swinging the instrument from $C D'$ back to $C D$ again, thus:

$$S_4 - S_3 - P + S = 0. \qquad (3)$$

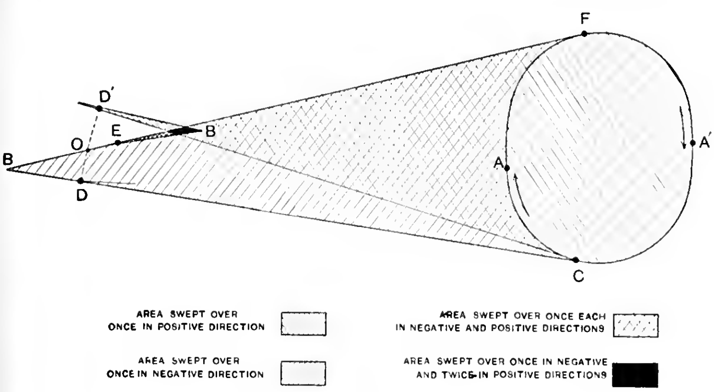


Fig. 3.

P represents, of course, the action of returning the instrument to its initial position, an action necessary to complete the proof, but not necessary in the actual measuring of the area of the desired outline. By assuming that S_1 equals S_2, in the preceding paragraph we proved that $P = S_3 - S_4$. Substituting this value in formula (3) we have the expression:

$$S - P - P = 0 \quad \text{or} \quad S = 2P. \qquad (4)$$

That is to say, the area which we desire to measure is equal to twice the area included between the initial and terminal positions of the planimeter. This area is in the form of a sector of a circle and the area of a sector of a circle is equal to the radius multiplied by half the length of the arc. In this case the area of P will be equal to $l \times \frac{1}{2} D D'$. Substituting this value for P in formula (4), we have:

$$S = l \times D D'. \qquad (5)$$

The length of the instrument, l, is a constant quantity, and for measurements in English inches may well be made 10 inches long. If, then, we measure the distance between D and D' and multiply it by 10 this will give us the value in square inches of the area we desire to measure.

It will be remembered that we made the assumption that $S_1 = S_2$. In order that this assumption may be realized, a condition which is necessary for the correct working of the instrument, we must start the tracing of the outline, or in other words, locate C, in such a position that arc $D D'$ will cut across curve $D B B' D'$ in such a way as to make these two triangles, $D B O$ and $O B' D'$ or S_1 and S_2 as we have called them, equal. In general, they will be practically equal when the instrument is started in such a position that a normal to the curve at the starting point will pass through the center of gravity of the area. By observing the nature of the curve $D B B' D'$ it will be seen that considerable variation may be allowed in the location of point C without sensibly affecting the length of arc $D D'$, which is the measure of the desired area.

M. Flamant, who wrote the article in the *Revue de Mecanique* referred to above, says in relation to the best method of using the instrument: "The operation of measuring the area of a surface is so simple tnat it is advisable to do it a second time in each case, especially if the operator has not acquired considerable facility in the use of the instrument. To do this the figure may be turned half-way around and the tracing started from a point diametrically opposite to the first, or else, which amounts to the same thing, one may start from the same point but work with the hatchet end at the right hand instead of at the left. The mean of the results of the two operations may be used if they agree closely enough with each other. If there is considerable variation between them, one of the two at least is wrong."

Referring to the method which was illustrated in our September issue he says: "By a complicated calculation, on the whole rather barren of results, it can be demonstrated that if instead of starting the tracing from a point in the outline, as we have supposed, the tracing be started from the center of gravity of the area which we wish to measure, then by following a definite line to a point on the contour, the tracing point be carried around the outline and returned to the center of gravity again, following the same line in a contrary direction, then the condition necessary to make the areas S_1 and S_2 equal to each other is apparently realized. In reality the result is only approximate and is scarcely more exact than that obtained by starting the tracing from a point judged by the eye as before explained, so I am led to put this method on record without recommending the use of this supposed refinement."

* * *

One of the old questions asked to puzzle would-be scientists is "What becomes of the energy of a coiled spring that is dissolved in a bath of acid?" Evidently this question was entirely hypothetical for it appears to be practically impossible to dissolve a spring under tension in acid for almost as soon as the acid touches a spring in such condition it cracks and breaks. The cause of this phenomenon appears to be the absorption of hydrogen generated by the acid reaction which

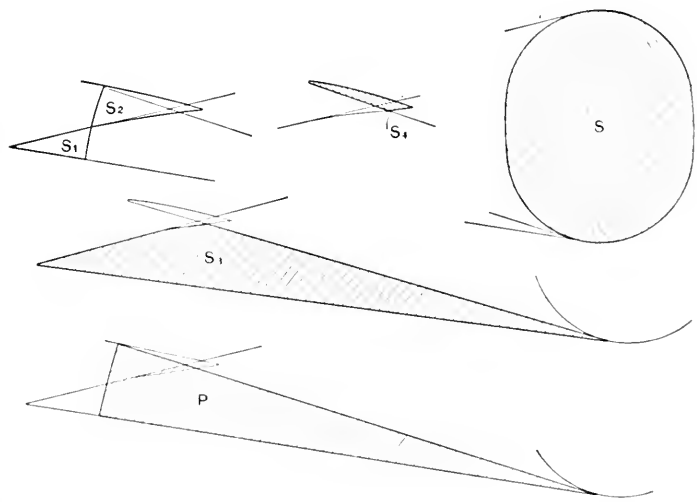


Fig. 4

makes the steel very brittle. Steel has great affinity of hydrogen, especially when hot, and this is oftentimes the cause of its deterioration when worked. It has been found that steel at red heat will occlude 20 times its volume of hydrogen, according to a statement made by Mr. Maunsel White of the Bethlehem Steel Co. The hydrogen gas is not in chemical union and can be driven off by heat. Steel wire after pickling becomes very brittle but if heated to a cherry red and annealed the hydrogen is driven off and it becomes ductile again.

SOMETHING ABOUT THE MANUFACTURE OF BELLS.

Some months ago the writer had the pleasure of visiting the well-known bell foundry of Meneely & Co., West Troy, N. Y. This concern was established in 1826, and, therefore, has a manufaturing history of sixty years, a span of time that few concerns in this country can boast of. Mr. F. P. Lotz, the superintendent, who it will be remembered wrote an interesting article for MACHINERY, February, 1905, on the manufacture of bells, says that the standard bell metal is copper 78, tin 22, or copper 77, tin 23. Silver was never used in the manufacture of bells, although the impression that such was the case was carefully cultivated in ancient, and even in modern times. Mr. Lotz showed the writer how the silver was (not) used when, with certain appropriate religious ceremonies, it was supposed to be mixed with the bell metal. It was simply thrown into the firebox of the reverberatory type of furnace, which has for many years been used for melting bell metal, and the fire was industriously poked so that the silver coins soon fell through the grate bars into the ash-pit. Needless to say, they were removed and pocketed by the bell founder and his assistants after the heat was taken off, while the good people went home in exaltation of mind over their generous and sanctified gift to the church.

Bells are cast as nearly as possible to the exact shape required, and no machining is done on them save the polishing, which is done in a primitive lathe. Sometimes in order to make some of the bells of a set of chimes of the correct pitch it will be necessary to sharpen the edge of the mouth a certain degree, but this is done by a polishing and scraping process rather than by the use of the lathe tools. Bell metal assumes a certain crystalline structure with reference to the exterior surface, and if that exterior surface is removed to any considerable depth the tonal character of the bell is likely to be entirely changed and ruined, for the artistic ear at least. Bell metal is almost universally melted in air or reverberatory furnaces, this being a furnace, of course, having a firebox at one end and the chimney at the other with a chamber between in which the crucibles containing the bell metal are set. A door in the side is provided for giving access to the melting chamber. Over this is a reverberatory arch which deflects the heat downward in its passage from the firebox to the chimney and heats the crucibles. With this construction in mind, the joke of putting the silver coins and trinkets into the firebox can be better appreciated.

The secrets of bell making, if there are any, are the methods of determining the bell contour, and not in the mixtures. Most makers of prominence have their own methods for determining the shape of a bell for a certain size and tone; these methods are usually graphical, although the size of the bell is determined mathematically for the note desired.

* * *

CRAB COUPLINGS.

The simple "crab" couplings are quite commonly used in mill construction and in the rougher and heavier forms of machinery. A correspondent has sent in a blueprinted table giving the dimensions of various sizes of this device to fit shafts ranging from 1 to 7 inches in diameter. This table will be found in the data sheet sent with this month, together with a figured sketch to show the design of the coupling and locate the dimensions. The way in which the parts increase in size as they are applied to larger shafts illustrates a point that will be noted by any one who has to design a series of machines or fittings of different sizes made in the same general design. It is not possible, as one might imagine who has never tried it, to make the coupling for two-inch shaft one-half the size of a four-inch shaft, keeping the ratio of ½ to 1 throughout each of the dimensions. The two-inch coupling, if made in this way, will be found to look out of proportion and will apparently be considerably weaker for the work it has to do than is its prototype. This phenomenon is probably largely a mental one and is perhaps due to an instinctive knowledge on the part of the designer that a given defect or irregularity in the castings or other parts of the smaller mechanism will reduce its effective strength proportionately more than it will in the case of the larger size. Aside from this point, the accidental stresses and overloads to which any mechanism may be subjected, are liable to be greater in proportion to the ultimate strength of the parts in the case of the smaller sizes. To allow for these considerations, and to satisfy the designer's sense of the fitness of things, the unit of measurement used for this line of crab couplings is not the diameter, or a fraction of the diameter, but instead a fraction of the diameter plus a constant quantity. From this unit all the proportions of the clutch except those which must be determined directly from the diameter of the shaft are calculated. As given in the data sheet this unit is given under the column marked δ and is equal to $\frac{D}{3}+\frac{1}{4}$ inch. All the quantities on the sketch not otherwise marked, are decimals and multiples of this unit. All these various decimals and multiples are figured out and given in the table. It will be noticed that where the ends of the two shafts come together a recess of ½ the diameter of the shaft has been bored in one, into which projects a corresponding plug from the end of the other shaft. This is to prevent the lateral deflection of the shaft which would result from using, to transmit a heavy torsional pressure, a clutch whose claws did not bear together evenly.

On the two remaining data sheets are given diagrams furnished by the president of an engine-building concern. These diagrams describe the practice of the firm in proportioning the arms of pulleys; their use will be readily understood without much explanation. For instance, on the eight-arm diagram, if it be desired to determine the size of the arms for a pulley 15 feet in diameter and 36 inches face, the horizontal line marked 36 at the right of the diagram where the width of the wheel is given is followed on until it intersects with the curve marked 180 which stands for 180 inches or 15 feet, the diameter of the wheel. From this point of intersection the width line is followed down to read the graduation at the bottom of the diagram. This vertical line corresponds to 7⅜ inches, which should be the width of the arm at the center of the wheel. A circle of this diameter may be drawn at the center of the wheel, and two tangent lines drawn from it on opposite sides, tapering together at the rate of ⅜ of an inch to the foot, will give the proper width for the arms of an 8-arm pulley of this size. The thickness should be one-half the width. The 6-arm diagram is similarly read.

* * *

A recent issue of *The Foundry* contains a communication "The Foundry is no Place for Girls," which expresses sentiments that exactly coincide with our own views on the subject and which we would commend to the careful attention of every foundryman who is thinking of using female labor for coremaking and other light foundry work. That such work is degrading to womankind can scarcely be questioned, but if there is any doubt it has only to be seen once to be thoroughly convinced that it is a fact. The letter was written after a visit in company with a party of mechanical engineers to one of the largest industrial establishments in the vicinity of New York City. The layout and equipment of this plant attracted universal admiration except for the one feature in the foundry where a large number of girls and women (some foreigners) are employed in making cores. It is hard enough for a man to work ten hours in an atmosphere of gas and dust at labor that soils his hands and clothes to such an extent that any pretense at neatness is impossible; when he goes home, however, he enters another world that seems all the better for the contrast. But if the women who make the homes are brought into immediate contact with the brutalizing conditions of foundry work what will the homes become?

* * *

A little scheme that is sometimes used to prevent the bruising of machine screw heads which of necessity must be made with a slot and which have to be frequently adjusted, is to drill a hole slightly larger than the width of the slot in the center of the screw to a somewhat greater depth than the screw slot. The screwdriver is made with a peg turned on the end which fits into this hole and so keeps it centered and square with the slot.

PRESS TOOLS FOR MAKING A SEAMLESS COVER.

W. VAN ORMAN.

The following describes a set of tools for making a one-piece or seamless can cover which is done in two operations. While this work is not new I suppose there are others, who like myself, have often wondered how this work is done; I did not know until I had occasion to make the set of tools for this particular job, and although I do not know what methods other people employ I will try to give the readers of MACHINERY an idea of the construction used. But before proceeding to describe the working of these tools I would like to say a few words in regard to making these covers in one piece and the cost of a two-piece cover, for the benefit of those who are not familiar with this class of work; I will first give an idea of the work on a two-piece cover.

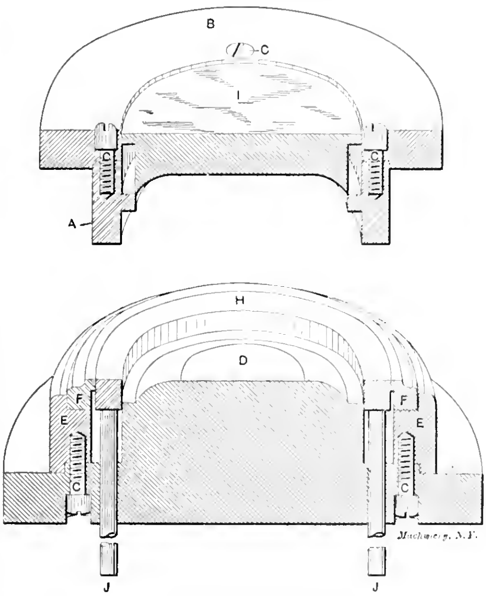


Fig. 1. Combination Forming and Blanking Die.

A two-piece cover is one in which the rim is cut separate, soldered together and afterward burred in by hand. Now, these covers had been made ever since I was employed by the company at a cost of $7.70 per thousand for the labor, to say nothing of the cost of the gas required to heat the irons or the solder required to fasten the rims together. The improved press tools which make the covers in one piece have reduced the cost to $2.30 per thousand, and now every cover is just alike.

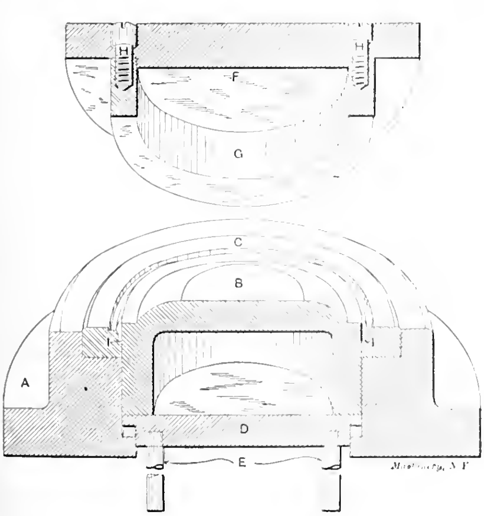


Fig. 2. Second Operation Punch and Die.

Figs. 1 and 2 show the first and second operation dies and Fig. 3 shows the trimmer; Figs. 4, 5 and 6 show the cover after the first and second operations, and the trimming operation. Fig. 4 shows it as it comes from the die; Fig. 6 after it leaves the second operation die, in the finished state.

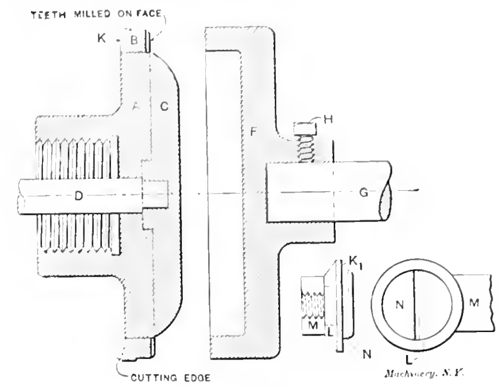


Fig. 3 Trimming Dies.

The trimming operation follows the first operation, being performed on a turret lathe as will be described later on.

The first operation tool is a combination forming and blanking die and is of composite construction. The forming punch, *A*, is made of tool steel and since it only cuts tin it is left soft. It is fastened to the cast iron piece, *B*, by means of the fillister screw, *C*, and the piece, *B*, is countersunk for about 1/8 inch to receive the punch, *A*. The punch is made a nice easy driving fit in *B* so there is no chance for it to shift position, and this construction makes doweling unnecessary. *D* is the forming plug made of cast iron turned to the required shape. *E* is also of cast iron and this part holds the cutting die, *F*. The same construction is employed as in the punch, the ring *E* being fitted closely over a turned shoulder and secured with the fillister head screws, *C*. The cutting die, *F*, is hardened and drawn to a dark straw color, and after being driven into the ring *E* it is ground to size. *H* is a cushion ring and stripper combined and is made of machine steel. When the ram of the press descends the blank is cut by the punch, *A*, and is held between the punch and the cushion ring until it is formed up. On the up stroke of the press the piece is stripped from the plug by *H*, and the kicker or knockout, *I*. The knockout is a piece of cast iron formed to the shape of the cover, and is worked by a rod running down through the ram of the press. There are six cushion pins, *J*, which extend through the bolster plate and come in contact with the cushion plate. After the die has been set the cushion ring, *H*, is then put into place so that it rests on top of the cushion pins. There are two finger gages on each die which are not shown, also two holes are drilled through the ring *E* for the purpose of driving the ring out when required.

Fig. 4. Work as it leaves the First Die

All the parts of this die which come in contact with the metal are polished smooth and bright so that there shall be

no tool marks showing on the piece formed. The smooth finish allows that the metal be drawn more freely. Vent holes are provided of course for the escape of air. In the use of this die I found that a little tallow used occasionally is a great help as it allows the metal to slide more freely between the punch and cushion ring.

The second operation die is not so complicated as the first but is the one that gave me the most trouble. The body of the die, *A*, is of cast iron and bored out to the size of the inside rim of the cover. The cast iron plug, *B*, was turned to the shape shown and was made a close working fit in *A*. The tool steel ring, *C*, was made a driving fit in *A*, and is two

Fig. 5. After the Completion of the Trimming Operation.

thicknesses of metal larger than the plug *B* for ⅜ inch in depth. The upper half of the die, *F*, which is cast iron, is fastened to the ram and the steel ring, *G*, is secured to it by the fillister head screws, *H*. The ring, *C*, is counterbored about ⅛ inch deep, and the punch is made the same size as the counterbore to make it easy in setting the die.

After the covers have been trimmed they are placed upon *B* and as the ram of the press descends it forces the plug, *D*, down and the outside edges of the cover come in contact with the shoulder, *I*, which forces the metal to turn upward, for there is no other place for it to go. The mouth of ring *C* is belled just enough to make sure of the cover entering each time. This completes the one-piece cover.

Fig. 6. The Finished Work.

It may be of some interest to relate a few of the troubles which I had with the second operation in getting it to work to my satisfaction and produce a perfect cover. Since it was a hinge cover the rim was made only ⅜ inch high whereas if it had been intended to be a removable cover to fit a pail or something similar it should have been ½ or ⅝ inch high. The principal feature to mention, however, is the difficulty experienced in upsetting the metal so as to form the flange which keeps the cover from dropping down in. The trimming must be done exactly right. If there is too much metal, the straight part which fits the pail will be buckled and the flange will be distorted. If, on the other hand, there is not enough metal the flange will not be fully formed. This cover was trimmed so that the lip measured 11/16 inch and this amount formed a nice smooth rim ⅜ inch high and a flange 5/32 inch wide all around.

As we had no trimmer for trimming the covers after the first operation one was made which is shown in Fig. 3. *A* is a piece of cast iron threaded to fit the spindle of a monitor lathe and *B* is a tool steel ring that is cut on the face something after the fashion of a milling machine cutter; this part is made a driving fit on *A* and is hardened and drawn to a dark straw color. After having been driven on to *A* it is ground on the face so as to run true. *H* is a piece of cast iron which acts as a holder while the covers are being trimmed and *G* is a piece of machine steel on which it is mounted for holding in the turret head of the lathe. *C* acts as a kicker or knock-out, being worked by rod *D* which runs through the hollow spindle of the machine. The tool for trimming is shown in the same view. The shank, *M*, fits in the toolpost in the cross slide and the revolving cutter, *L*, is a piece of tool steel turned to shape, hardened and ground. It acts by shearing off the metal between the edge *K* on *B* and K_1 on the cutter; it makes a nice clean job, square and accurate, and is rapid in use.

* * *

THE ADVANCE IN THE PRICES OF MACHINE TOOLS.

As reported elsewhere in this paper, the builders of lathes, planers, shapers and upright drills, who are members of the National Machine Tool Builders' Association, have advanced the prices of their products by amounts varying from five to ten per cent. Advances in other lines are quite likely to follow. Letters were sent out from this office to a number of the firms concerned in the movement, asking for definite information as to the causes of this advance. The answers received present quite clearly the builders' side of the question, giving definite figures, in most instances, to uphold the contention that the advance does no more than cover the increase in the cost of production during the period since prices were last determined. The following extracts will illustrate the general tenor of the replies:

"During the past six years cast iron has advanced, with us, 10 per cent. We are paying about the same wages as in 1901, but more than in 1903 or 1904. We are now paying about 5 per cent more than six or eight months ago. The cost of cast iron and labor each constitute about one-third the value of our product. Hence, if we have to pay 10 per cent advance on material (one-third the value of our product) and 5 per cent advance on wages (one-third the value of our product), it means that about five per cent should be added to the price of our product to cover the advance in cost of manufacture."

"If there had been absolutely no advance in material the general growth and improvement of machine tools would justify the recent advance in price. The lathe or milling machine of to-day is no more like one made five or six years ago than a fine Swiss watch is like an Ingersoll. Five years ago practically all the detail parts of machine tools were made of cast iron. To-day these are all made of steel. Where belt feeds and small light feed belts were formerly used, intricate gear feeds and much heavier driving construction is used on all machine tools. For instance, a No. 2 miller will weigh more, pull a heavier cut, can be handled quicker and do more work than a No. 3 machine would as manufactured five or six years ago. This same illustration will hold good of practically all machine tools. The only trouble with the Machine Tool Builders' Association is that they have not kept their prices in line with the added improvements of the tools to say nothing of the increased cost of material and labor. Five years ago we were all working on a 60-hour basis; to-day we are working on a 55-hour basis. This single item, not considering any other, is equivalent to a 12 per cent additional cost, because it has not only increased the cost per hour, but the general expense has to be divided among fewer productive hours."

"We give below the increased cost of labor and material during the past year, which has been more than sufficient to justify all advances made by manufacturers:"

	Per Cent.		Per Cent.
Labor	5 to 10	Composition castings	35
Castings	10	Machine screws	25
Machinery steel	20	Drop forged wrenches	10
Babbitt	70	Lumber	20

"To justify the recent advance in price, it will be necessary only to refer to the advances in costs to us during the same period. Labor has advanced very materially and we find the cost of the following items has increased as set forth:"

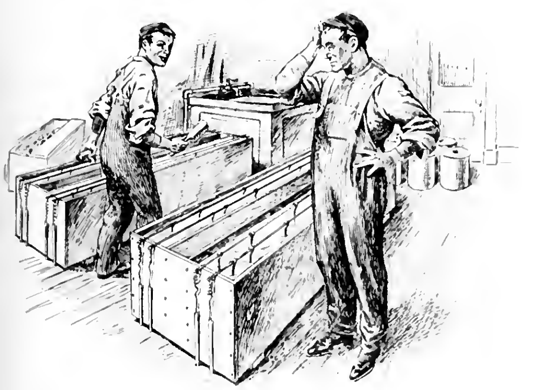
	Per Cent.		Per Cent.
Steel forgings	20	Cast iron	7½
Bar steel	10	Cast steel	4
Screws	30	Motors	5
Nuts	5	Lumber	28
Coal	8		

"There are many causes for a rise in the price of machine tools, the most important being the increased price of both labor and material. Cast iron is at a very high figure at the present time, and labor is getting more for its services than ever before. Bar steel, brass and all other materials entering into the construction of machine tools are higher than they have ever been. Another feature, and by no means the least important, is the cost of alterations, new patterns, etc., which have become necessary during the past four or five years, in order to meet the demands put upon tools by the new high-speed steels. The tools, as built to-day, are no more like those which manufacturers were building five or six years ago than they were at that time like the old-fashioned chain lathe and screw planer. Purchasers of machine tools have not taken into consideration the tremendous cost to the manufacturers of all these changes. They expect that machine tool builders can furnish machines weighing anywhere from 33 1-3 to 200 per cent more than formerly without any extra cost for the tool. Incidental to this is the enormous expense of making patterns, drawings, jigs, and new tools, for none of which did the machine tool builders receive sufficient remuneration. Furthermore, they would submit tools to any strain which they might desire and if the tools did not stand up to the work, it was the fault of the tool and the expense of the repairs and alterations must all be borne by the manufacturer. The machine tool business requires a larger investment of capital than any other line of business of which we are familiar, and yet the dividends of machine tool builders have never been what could be termed more than fair."

* * *

THE BLUFF THAT GOT CALLED.

We had a new plater come in lately to take charge of the finishing room. He is an old fellow and his hair is white, but he is all there; he has been around a good deal and seen things. We both carry our lunch (for that matter the whole shop does) and the other noon-time he got "chummy" and told me a lot of things—where he had worked; what he had done, and things he had run up against, but the best thing he told me was his experience with aluminum work.



The man looked kind of queer.

He had taken charge of the polishing room in a big bicycle factory, and as it was a good berth, he was very anxious to make good. Things went on all right for a week or so, and he was getting so he felt solid. Every lot of work that came into the room had a tag on it—a "work tag," as it was called—telling just what was to be done on that lot of work. One day a pan full of aluminum work came in, saying on the tag: "Polish and plate." Now aluminum was a new metal in those days, and though Frank had polished a little of it, he didn't know the darn stuff wouldn't plate worth a cent. It went through the finishing room all right, and when it came to the plating room, Frank said to the man: "Wash it up well and put it in the white metal bath." The man looked at Frank kind of queer, but it's a good man that does as he is told, and into the bath it went. Frank run it an hour or two, then took a look at it. Not a plate. He put on the current a while longer, then looked again with the same result. He tried his hydrometer in the bath, but it was all right, then he went to the man and blew him up for not having washed it clean; told him to take it out and put it into the potash, and then into the bath again. The man said not a word, did as he was told and put it in the bath again. He ran it several hours, but not a plate. By this time Frank was getting the cold chills down his back and was feeling pretty desperate, and as Frank said: "It was right here that I made the break."

"Don't you know that aluminum can't be plated."

He had just got hold of a circular of a new plating salts guaranteed to plate anything, and grabbing the circular, and one of the aluminum castings, he bolted into the superintendent's office. The old man was in and Frank "broke his egg."

"I am having a little trouble plating these aluminum castings, and you will have to get me a lot of these salts, about five pounds will do, I guess." The old man looked at Frank, then at the aluminum, and then back to Frank. "You darn fool," he blurted out, "Don't you know that aluminum can't be plated? I thought you were a good man, and I had got a prize, but I think you are a d——n bluff. Go to the paymaster and tell him to pay you off up to the end of the week; never mind about working out your notice. You will be trying to plate the dynamo next."

"I didn't say a word," said Frank, "but it was the first and only bluff I ever tried to put up, and it learned me a lesson and that was: 'To keep away from the superintendent's office unless I was sure of my ground, or was sent for, and had to go.'"

Frank has made a good many attempts to plate aluminum since that time, and he gave me a receipt that would come nearest to depositing a plate on aluminum of anything he had ever found. The five-minute whistle blew and we filed in past the clock, but I could not forget "the bluff that got called."

A. P. Press.

* * *

Oil squirt guns, air pumps, etc., which have no leather packing, are now being manufactured for automobile use. The brass pistons are accurately ground to fit drawn brass cylinders so closely as to be air-tight and yet work freely. This construction is advantageous as a pump so made wears a long time without leakage. A squirt gun made with leather packing is quickly rendered useless when used with gasoline, for gasoline rots leather. The same construction is being employed for handling certain chemical solutions which do not affect brass, but which quickly destroy any vegetable or animal substance used for packing.

CHATTANOOGA MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers held at Chattanooga, Tenn., May 1 to 4, was in several respects an unusually successful convention. The attendance was small, since there is not a large membership of the A. S. M. E. in the South and Chattanooga itself is not near the center of engineering interests in this country. Chattanooga as a meeting place has scenic and historic advantages second to no other city and the attending members and guests found the four or five days of the convention altogether too short for the excursions planned by the local committee, to say nothing of the time required for the professional sessions, which, as a matter of course, ought to be the leading feature, but unfortunately seldom are at the spring meeting.

At the first professional session on May 2 the several business items on the calendar were attended to. These included the report on the election of members; a report on the Carnegie building for the engineering societies in New York, stating that the steel frame of the structure is already completed and the walls are complete up to the thirteenth floor; and the reports of the standing committees. Notice was given of proposed changes in the constitution and by-laws relating to details incident to the expenditures of the society; provisions for the appointment by the council of an honorary secretary; and the establishment of a permanent research committee having a membership changed by rotation, one member being elected and one retiring each year.

The papers presented, taken as a whole, were of high technical merit. It has lately been the custom to have some one subject predominate at the different sessions and a collection of papers presented to cover different phases of this subject. At this meeting Water Wheel Governing was the topic and was discussed in the following five papers: "Some Stepping Stones in the Development of a Modern Water Wheel," by Mark A. Replogle; "Regulation of High-Pressure Water Wheels for Power Transmission Plants," by George J. Henry, Jr.; "Speed Regulation of Water-Power Plants," by John Sturgess; "Turbine Design as Modified for Close Regulation," by George A. Buvinger, and "Efficiency Tests of Turbine Water Wheels," by William O. Weber.

In view of the remarkable development of water-power generating plants since electric generators and distributing systems have attained to their present state of development the question of speed regulation of such plants a most important one. The difficulties to be overcome in their speed regulation are enormous, owing to the inertia of the water tending to produce momentarily an effect opposite to that desired when the turbine gate is opened or closed. This is explained in a simple manner in the paper by Mr. Sturgess in the following words:

"The ultimate function of the gate is to control the power output of the wheel. It does so (or attempts to) by varying the aperture through which the water flows. It may appear at first sight that this means would directly accomplish the purpose, but a little consideration will show that it will not do so in the manner required under modern conditions.

"The gate consists, essentially, of an adjustable aperture, as stated above. It is set so that the water passes immediately from the aperture into the wheel, this remark applying alike to cylinder, register, wicket and other forms of gates as found on water wheels of the present day. Reducing the aperture (closing the gate) is intended to reduce the power output of the wheel, and increasing the aperture (opening the gate) is intended to increase the power output.

"It will, however, be obvious that simply *increasing* or *decreasing* the aperture will not cause the power developed by the wheel to vary in like manner for the reason that any sudden restriction in the aperture cannot instantly check the velocity of the mass of moving water extending throughout the whole hydraulic system. The immediate effect of reducing the aperture is to cause the *same mass* of water to be ejected on the wheel, but with a *higher velocity*, thus actually increasing the power of the wheel at the very moment when uniformity of speed demanded that it should be decreased. On suddenly increasing the aperture, the reverse effect takes place."

Next in interest to these several papers upon water wheel governing, but first in importance, is the paper upon the collapsing pressures of Bessemer steel lap-welded tubes, 3 to 10 inches in diameter, by Prof. Reid T. Stewart. This paper is abstracted in the Engineering Edition this month and contains the most complete and reliable information ever presented on this subject. In fact, these tests show that previous formulas for collapsing pressures upon which engineers have placed their reliance are entirely erroneous under the present state of the art. It is seldom that the society is able to place upon its records the results of so comprehensive a series of tests as were made by Prof. Stewart at the instigation of the National Tube Co.

Two important committee reports were submitted: one upon standard proportions for machine screws and one upon the Pennsylvania Railroad locomotive tests conducted at the Louisiana Purchase Exposition. The recommendations of the committee upon machine screw proportions are to come up for further discussion at the next annual meeting, and so are not final, but we publish an abstract of their report in another part of the paper, since this subject is one in which all machine shop readers will be interested and we should like to give those subscribers to MACHINERY who do not have the proceedings of the A. S. M. E. an opportunity to judge for themselves of the work of standardization that has already been accomplished.

The report upon locomotive tests was by the committee appointed by the society to co-operate with the Pennsylvania Railroad, and a similar committee appointed by the Master Mechanics' Association, in conducting tests at the locomotive testing plant installed by the Pennsylvania Railroad at the Louisiana Purchase Exposition. Eight locomotives were tested during the exposition and results of these tests have been recorded with great elaboration and detail in a large volume issued by the Pennsylvania Railroad. The report of the committee submitted at the Chattanooga meeting summarized the most important results and is a valuable contribution upon the subject of locomotive performance.

Two of the papers presented had previously been given at the local meetings of the society held during the past winter at New York City. These were "Low-Resistance Thermo-electric Pyrometer and Compensator," by Prof. Wm. H. Bristol, and "A History of the Introduction of a System of Shop Management," by James M. Dodge. These papers have already been noticed in previous numbers of MACHINERY and it need only be said that Prof. Bristol has undoubtedly succeeded in producing a pyrometer simple in construction and inexpensive to maintain, which can be used successfully in commercial work. Not only is this of great importance in strictly metallurgical operations, but it should serve a most useful purpose in the treatment of high-speed steel in machine shops. Other papers were "The Effect of a Blow," by Alexander W. Mosely and John Lord Bacon; "A New Liquid Measuring Apparatus," by Geo. B. Willcox, and "The Improvement of the Tennessee River Power Co. at Hale's Bar, Tenn.," by Thos. E. Murray.

The first of these, which is of the greatest interest to machine shop readers, proposes a plan for rating steam and power hammers by using a standard plug to measure the effect of a blow. Plugs of Bessemer steel rods were used in the experiments outlined. When erected on the center of the anvil the hammer was allowed to fall freely from a given point. Knowing this weight and the distance through which it fell its kinetic energy could be determined and the compression of the plug gave a means for finding the force of the blow. From these data the loss of energy in the hammer could be determined.

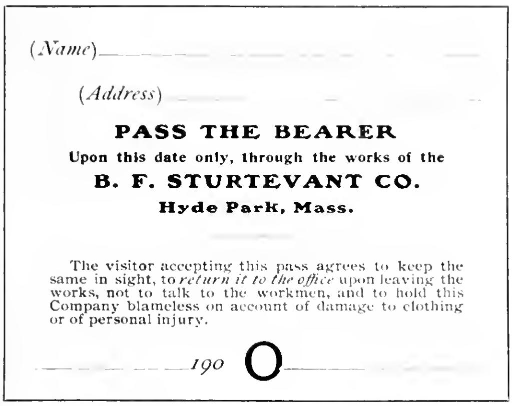
* * *

During the Master Car Builders' and Master Mechanics conventions to be held at Atlantic City, June 13 to 20, the Niles-Bement-Pond Company will have on exhibition and in full operation one of their extra heavy 90-inch driving wheel chucking lathes. This will afford an exceptional opportunity to observe this machine at work. Owing to its great weight, this machine cannot be shown on the steel pier. They have therefore built a special booth two minutes' walk south from the Pennsylvania R. R. station on New York Avenue, near Atlantic Avenue, where all are cordially invited to witness a demonstration of this machine.

LETTERS UPON PRACTICAL SUBJECTS.

SHOP VISITORS—ROLLING IN BABBITT—PLANER TOOL LIFTER.

I enclose a few photographs that may interest some of your readers. Fig. 1 shows a "pass card," used by one of the largest firms in the country in their special line. The card serves as a pass through their works, and also as a permanent record of their visiting friends. It is the standard 3 x 5-inch size,



(*Name*)

(*Address*)

PASS THE BEARER

Upon this date only, through the works of the

B. F. STURTEVANT CO.

Hyde Park, Mass.

The visitor accepting this pass agrees to keep the same in sight, to *return it to the office* upon leaving the works, not to talk to the workmen, and to hold this Company blameless on account of damage to clothing or of personal injury.

190 O

Fig. 1. Pass-card used at the Sturtevant Shops.

and appeals to me as the neatest method of several that I have seen, and is in direct line with the present tendencies of office records.

Many of your readers have visited the works of the Brown & Sharpe Mfg. Co., Providence, R. I., were asked to register, and are familiar with the "big book." In my case this has happened several times, and always the thought has come: what an interesting hour could be spent looking over the names in it, some of which are used to conjure by in the mechanical world.

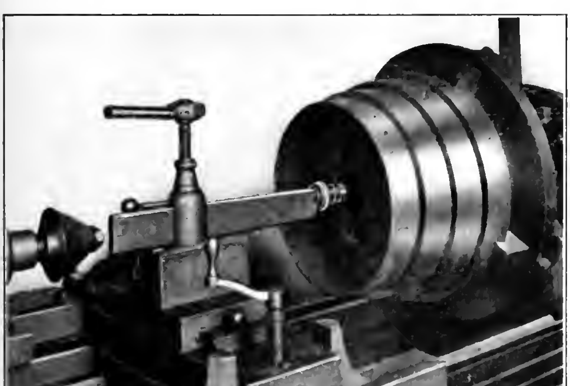


Fig. 2. Rolling Babbitt in a Cone Pulley Bearing.

At the Washburn shops of the Worcester Polytechnic Institute, a register of names has been started, and already contains the signatures of visitors from all parts of the world. It would seem to the writer that every shop should have a register of visiting friends, in view of the fact that almost universally are our shops open to visitors.

Fig. 2 shows a home-made method of rolling the babbitt in a large, loose pulley cone of the design shown in Fig. 3. The babbitted hole was in this case enlarged after babbitting and before boring nearly an eighth of an inch with comparative ease. An old lathe tool with the end forged down, turned and threaded to make a stem on which to mount a roll, is a job that can be done by anyone, and is the tool shown. If many such holes are to be rolled, some sort of an expansion roller mandrel is the tool to use, but in this case none was at hand, and it was not deemed advisable to go to the expense of making so elaborate a tool for a single hole.

In Figs. 4 and 5 is shown a simple device for lifting and supporting the tool during reversal of a planer. This device can be made automatic by arranging the proper connections, but as used on this job is more convenient as shown. The cam is made by forging a piece of flat stock into the shape shown, and smoothing the edges on a grinding wheel. The block, into which the holding bolt screws, is threaded to fit the binder bolts in the clapper, and is afterward split for convenience in attaching. H. P. FAIRFIELD.

Worcester Polytechnic Institute.

SOME DRAFTSMEN'S AND DESIGNERS' KINKS.

Herewith I submit a few "kinks and things" which have helped me. While these are not new to all, I trust that they will interest a number sufficiently to justify their publication. Some simple problems are at times quite puzzling by reason of the way in which they are presented. Data is not always at hand, and what follows can be easily remembered.

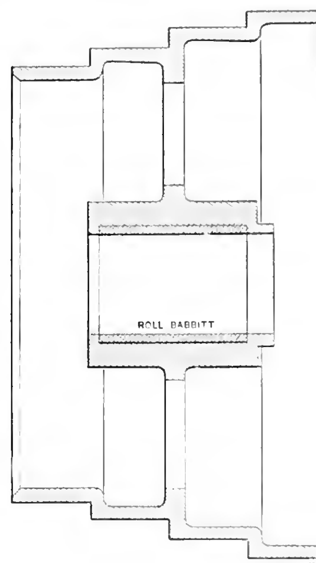


Fig. 3. Section of Pulley shown in Fig. 2.

To find the diameter of gears when the center distance and velocity ratio are fixed: Divide the center distance (in inches) by the sum of the numbers comprising the ratio; multiply this quotient by each of the terms of the ratio. The products thus obtained are the radii in inches of the gear and pinion, and the rest is easy. To illustrate, suppose the center distance = 22.5 inches and the ratio = 0.8 : 0.3, or 0.3 of a revolution of the gear must drive the pinion 0.8 of a revolution. $0.8 + 0.3 = 1.1$, and $22.5 \div 1.1 = 20.4545 +$.

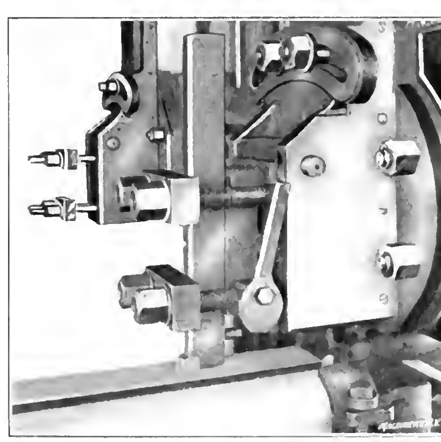


Fig. 4. Tool Lifter in Working Position.

$20.4545 \times 0.8 = 16.3636$ inches = radius of the gear.

$20.4545 \times 0.3 = 6.13635$ inches = radius of the pinion.

$16.3636 + 6.13635 = 22.49995$ inches = the center distance, very nearly.

The number of teeth in the gear and pinion must, of course,

be the exact ratio. If, in the above case, the gear and pinion contain respectively 64 teeth and 24 teeth, the circular pitch is 1.606 + inch.

The ratios 0.8 : 0.3 may be conveniently changed by multiplying both terms by, say, 5, which gives 4 : 1.5, and the result will be the same.

If the sum of the terms equals 1, or if the ratio can be reduced so that the sum of its terms equals 1, it is only necessary to multiply the center distance by each of the terms of the ratio, as, for example:

Center distance = 22.5 inches, and the ratio = 1.5 : 1; then $1.5 \div 2.5 = 0.6$, and $1 \div 2.5 = 0.4$, that is, 0.6 : 0.4 the sum of which is 1. Hence $22.5 \times 0.6 = 13.5$ inches = radius of gear, and $2.25 \times 0.4 = 9$ inches = radius of pinion.

When the center distance and velocity ratios are fixed by some essential construction of a machine, it is usually impossible to use standard diametral pitch gear teeth. If cast gears are to be used it does not matter so much, as a patternmaker can lay out teeth of one pitch as well as another, but if cut gears are required an effort should be made to alter the center distance so that standard cutters can be used.

When designing a pattern from which only one or two castings are to be made, do not go to extremes to save weight in the casting. The extra work required of the patternmaker may cost more than the saving in metal would amount to. If appearances are an important consideration, that, of course, is another matter.

In developing a grooved face cam, first lay down two horizontal lines, the length of which is equal to the circumference of the cam at the bottom of the groove, and the distance apart equal to the width of the cam over all. Divide the lower line into 24 equal parts, and one of these spaces (preferably the one at the left) into 15 parts. Each of the 24 spaces represents 15 degrees and the 15 smaller spaces each represent one degree of the circumference. If the movements are timed by binary or other divisions of a revolution which are not multiples of 360, divide the upper line into as many such parts as are necessary to locate the points where the path changes its course. By projecting lines from these points to the lower line it is easily seen how many degrees each movement and dwell occupies, also the number of degrees from a given point on the circumference to any other point. The keyway may

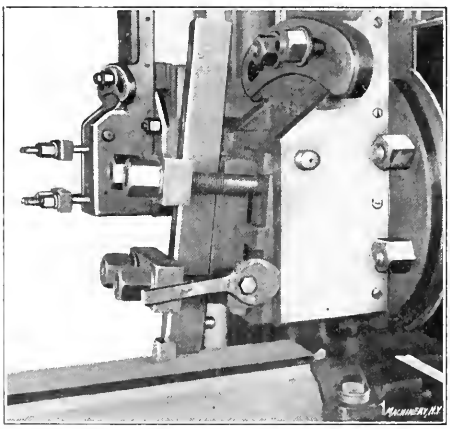


Fig. 5. The Tool Raised.

safely be located, unless for very accurate work. Of course the exact relation of this cam to other cams or gears must be known, and the keyseats in the shaft for related cams and gears should be in line.

When designing a new machine, first know exactly what it has to do; decide upon the order of operations, then make rough sketches of several ways, if possible, of performing each operation. After selecting what seems to be the best way of performing each operation, make assembly sketches showing plan and elevations. This gives a good general idea of the machine without wasting drawing paper, and is much quicker than making drawings to scale. When the movements and general plan of the machine are decided upon, make assembly views to scale. If a complicated machine, make drawings of closely related parts assembled, for this is sometimes of more assistance to the machinist than an assembled view of the whole machine. The framing usually comes last and is made to conform to the necessary construction of the working parts, and should be as symmetrical and free from sharp inside angles as possible.

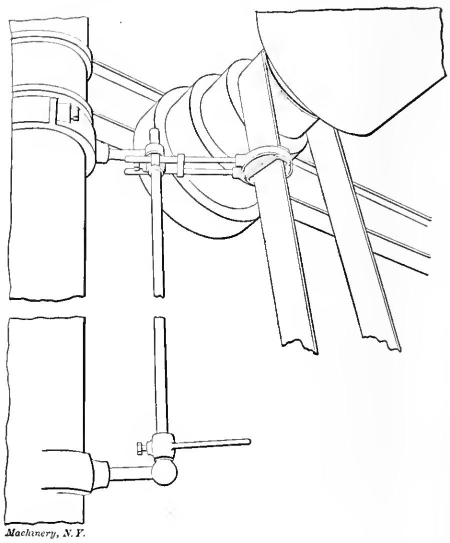
When a tracing is left unfinished on the board over night it takes ink much better the next morning if chalked again before beginning to ink. I use talcum powder, which seems to answer as well as prepared chalk, and it comes in boxes convenient to use.

Whittle a flat spot on the cork of the ink bottle just where your thumb rests when the quill is in position for filling a pen. Then you can always get the right hold on it.

Don't erase ink from tracings until it is thoroughly dry. If it is necessary to do any erasing, leave it until the tracing is finished and dry. By doing this, inking over an erasure is avoided.

HANDYMAN.

A GERMAN BELT SHIFTER.



A German Belt Shifter.

The belt shipper or shifter here shown is made by a German firm and may interest your readers. For convenience of application and ease of action it seems commendable.

Hanover, Germany. ROBERT GRIMSHAW.

MORE DRAFTSMAN'S DON'TS.

The don'ts for draftsmen recently published expressed very well some of my own ideas on the things that a draftsman should learn not to do. Here are some more which I feel should be more generally known by the drafting fraternity:

Don't fail to index a drawing properly so that it can be found readily when wanted.

Don't use too many large words on a drawing, but use plain and simple language in all cases.

Don't make three or four different views of a piece when one or two views will do as well.

Don't ever forget to put the scale on a drawing.

Don't give the same dimension twice, for it is liable to lead to errors when this dimension is changed.

Don't leave some dimensions to be gotten by adding a lot of other dimensions together or by subtracting them; all figuring should be done in the drafting room.

Don't leave out any data that should go on a drawing of a worm gear, bevel gear, etc.

Don't fail to use stock sizes of drills, reamers, etc., when possible.

Don't scrape off dried ink from the inside of a ruling pen with a knife or any hard instrument.

Don't allow any corrosion to take place on the inside of a

ruling pen; it must be polished and lapped out smooth to ink well.

Don't give strange names to the parts of a machine, but in every case strive to name each in a way that shall tell its mission in the machine.

Don't forget to give on the drawing of a collar or pulley the direction it can be reamed or bored from to help assembling.

Don't put on too much fancy shading and lettering on shop drawings, but strive to make good, plain, clear drawings, with plain lettering in all cases.

Don't fail to have all your work checked before it enters the shop. FRED. G. KENYON.

Providence, R. I.

* * *

TO CALCULATE THE CENTER ANGLES OF A PAIR OF BEVEL GEARS HAVING THEIR AXES AT OTHER THAN RIGHT ANGLES.

Fig. 1 represents the layout of a pair of bevel gears, the angle between their axes being represented by the bevel of x, in 12 inches. In cases where this angle is quite small, the following method of determining the angles AOB and BOC, in terms of the bevels y and z in 12 inches, may be used.

The known quantities assumed in the problem are the angle AOC and the gear radii AB and BC. Designate the radius AB by R, and BC by r. From the point A drop a perpendicular AE to the axis OC, and from B drop a perpendicular, BD, to AE. Then we have:

$$OA = \frac{AE\sqrt{12^2+x^2}}{x} = \left[r + R\frac{12}{\sqrt{12^2+x^2}}\right]\frac{\sqrt{12^2+x^2}}{x}$$

$$= \frac{r\sqrt{12^2+x^2}}{x} + \frac{12R}{x} = \frac{1}{x}\left[r\sqrt{12^2+x^2}+12R\right]$$

$$\frac{y}{12} = \frac{R}{OA} = \frac{Rx}{r\sqrt{12^2+x_2}+12R}$$

Also the slope, $$\frac{z}{12} = \frac{rx}{R\sqrt{12^2+x^2}+12r}$$

Having calculated the slopes of the pitch lines, the slopes of the outside, addendum lines $\frac{y_1}{12}$, and $\frac{z_1}{12}$, Fig. 2, may be computed.

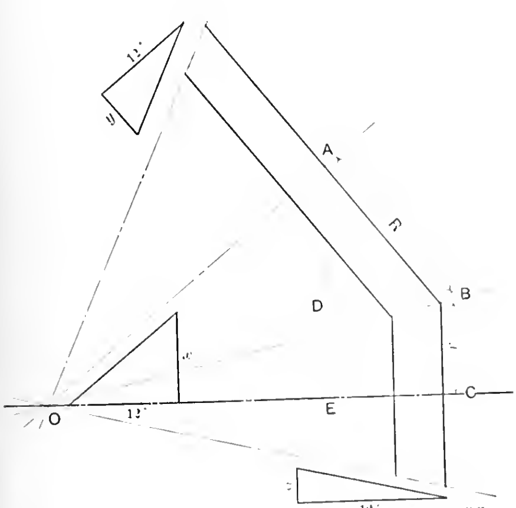


Fig. 1. Layout of Bevel Gear Problem.

Let d = the addendum laid off at C, perpendicular to the pitch line OC. Then

$$\frac{y_1}{12} = \frac{\left[R + \frac{12}{\sqrt{12^2+y^2}}d\right]x}{r\sqrt{12^2+x^2}+12R}, \text{ and}$$

$$\frac{z_1}{12} = \frac{\left[r + \frac{12}{\sqrt{12^2+z^2}}d\right]x}{R\sqrt{12^2+x^2}+12r}$$

Similarly, the slopes of the dedendum lines $\frac{y_2}{12}$ and $\frac{z_2}{12}$, are expressed by simply changing an algebraic sign, as follows:

$$\frac{y_2}{12} = \frac{\left[R - \frac{12}{\sqrt{12^2+y^2}}d_1\right]x}{r\sqrt{12^2+x^2}+12R}, \text{ and}$$

$$\frac{z_2}{12} = \frac{\left[r - \frac{12}{\sqrt{12^2+z^2}}d_1\right]x}{R\sqrt{12^2+x^2}+12r}$$

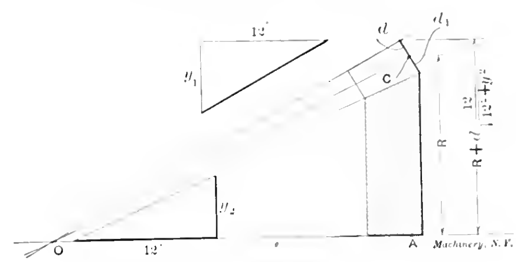


Fig. 2. Finding the Outside and Cutting Angles.

where d_1 = dedendum laid off at C.

For example, let

x = 2 inches

R = 10 inches

r = 5 inches

Then we have slope

$$\frac{y}{12} = \frac{10 \times 2}{5\sqrt{12^2+2^2}+12\times 10} = 1.327 \text{ inch in 12 inches.}$$

$$\frac{z}{12} = \frac{5\times 2}{10\times\sqrt{12^2+2^2}+12\times 5} = 0.661 \text{ inch in 12 inches.}$$

If the gears are 2 D. P., the addendum $d = \frac{1}{2}$ inch, and the slope of the addendum and dedendum lines will be

$$\frac{y_1}{12} = \frac{\left[10 + \frac{12}{\sqrt{12^2+1.327^2}}\times\frac{1}{2}\right]2}{5\sqrt{12^2+2^2}+12\times 10} = 1.39 \text{ inch in 12 inches}$$

$$\frac{z_1}{12} = \frac{\left[5 + \frac{12}{\sqrt{12^2+.661^2}}\times\frac{1}{2}\right]2}{10\sqrt{12^2+2^2}+12\times 5} = 0.726 \text{ inch in 12 inches.}$$

$$\frac{y_2}{12} = \frac{\left[10 - \frac{12}{\sqrt{12^2+1.327^2}}\times\frac{1}{2}\right]2}{5\sqrt{12^2+2^2}+12\times 10} = 1.26 \text{ inch in 12 inches}$$

$$\frac{z^2}{12} = \frac{\left[5 - \frac{12}{\sqrt{12^2+.661^2}}\times\frac{1}{2}\right]2}{10\sqrt{12^2+2^2}+12\times 5} = .595 \text{ inch in 12 inches.}$$

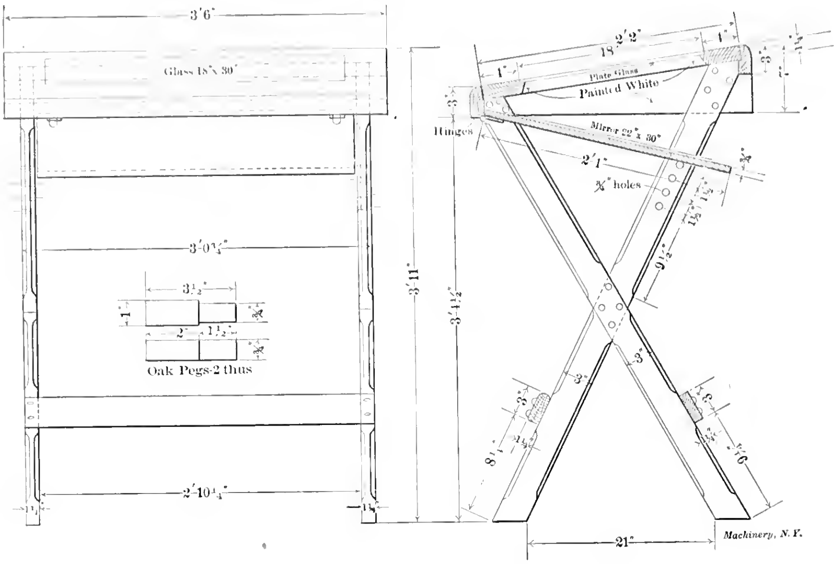
The dedendum, d_1, was assumed equal to the addendum, or ½ inch, which is near enough for this calculation.

Glenville, Ohio. A. L. WESTCOTT.

[The above-described method of figuring bevel gears has the merit of not requiring the use of a table of sines and tangents, or a protractor, so perhaps it may appeal to those of our readers who do not know how to use the one, and cannot borrow the other. It is difficult to see what other merit the process possesses, however, even in the case of small center angles, for which it is recommended, since the calculations are somewhat lengthy. The method is an ingenious one, however.—EDITOR.]

DRAWING TABLE FOR TRACING BLUEPRINTS.

The accompanying illustration shows a drawing table with a glass top that is designed to be used in making tracings of blueprints. The drawing is self explanatory and I have found



A Drawing Table for Tracing Blueprints.

a table made along these lines to be a very handy addition to a drawing office. The mirror underneath the glass top throws reflected light up through the blueprint to be traced and causes the lines to show very distinctly. A table we recently constructed was made at a total expense of $11.00, the labor, wood, and hinges amounting to $9.00, the mirror $1.05, and the plate glass 95 cents. It is not necessary to use the best quality of mirror or plate glass and this fact brings the cost down to a reasonable figure. R. F. KIEFER.

Sharon, Pa.

A WAIL FROM NEW JERSEY.

The spring days are getting in their work, and I get lots of requests for country jobs. One of the last that came in is so sad that I give it, verbatim. It is from New Jersey, so I do not blame him so much.

MY DEAR MR. PRESS:

Why don't you write and tell me that job in the country is ready? As the whistle blows at 7.00 o'clock in the morning it seems to say: "Come into the country," and as I punch the darned old clock it seems to ring: "Come into the country (no clocks there), and as I start the big lathe, the chatter of the back gear seems to say: "Come to the country," and the swish of the planer belt seems to say: "Come to the country," and the other day, after I had nearly ruined a big job because I presume my mind was on the country, the foreman came along and said: "Now, look here, my man, if you don't do better than that, we will send you out into the country."

As I went home that night, the flat-wheeled trolley car seemed to clamor: "Come to the country." Why I can even hear the rustling leaves in the tree tops and the frogs in the distant marshes, humming the same sad refrain: "Come to the country," but why continue; the only reason I am not now in the "bug-house" is that I have finally resolved to do my duty if it takes all my remaining strength. I shall probably lose two days' time in consequence of this, but never mind—I have written.

When I first came to the country, I hadn't a rag to my back, and now I am all rags, so Mr. Press, please get that job for me before it is time to plant potatoes.

I got it. A. P. PRESS.

THE IMPORTANCE OF HAVING THE FOUR FEET OF A LATHE STAND ON THE SAME PLANE.

My attention has been drawn repeatedly to the fact that comparatively few of the machinists or toolmakers who pose as first-class men realize how important it is, in order to bore a parallel hole or face a faceplate flat, that a lathe should have its four feet standing on the same plane, *i.e.*, to insure that the center line of the spindle and the ways on which the carriage travels may be parallel, the bed of the lathe must not be twisted by having one front leg resting on a higher or lower plane than the corresponding back leg.

Although I aim to have all my machines leveled up when they are installed, they do not always remain so, being on the second wood floor of a brick building. Generally when I insist on a new man doing his work accurately, before he gets used to my ways of doing things, he comes to me saying that the lathe he is using is a "bum" affair because it bores 0.0005 inch large at the back end of a hole that is, perhaps, 2 inches long, and he wants to try some other lathe to do the job. When I tell him to put a piece of tin under the back leg at the tail end of the lathe, and he finds, after doing so and taking another cut, that the hole is parallel, he says: "Well, that's quite a wrinkle. I didn't think such a thin piece would affect it so much." H. E. TWOMLEY.

Detroit, Mich.

WEAK HYDRAULIC FITTING.

The article in your May issue regarding a weak steam fitting, reminds me of an experience I had with a valve similar to this in hydraulic work several years ago.

I had rebuilt a hydraulic pump for a firm and also furnished them with a press for pressing wooden rolls into steel jackets. They did the piping themselves and the piping and the overflow were under the floor where they could not be readily reached. Upon starting the installation up, they complained that the pump would not do the work, and upon putting the gage on the same, I found that the best pressure I could get was about 400 pounds to the square inch. I jumped at the conclusion that the check valves were leaking and I spent two or three days alternately grinding the valves in and examining the same with a looking glass, and testing the pump.

The parties who had done the piping insisted that the piping was all right and the fault was entirely with the pump; therefore, on me. The way the press was operated was for the pump to run continuously and for the water to flow freely through the press cylinder when not in use, and when pressure was required the overflow was stopped with a plug cock such as I mentioned at the beginning. After trying everything I knew to make the pump work, and being unable to get a pressure over 400 pounds to the square inch, I insisted on their disconnecting the piping and allowing me to plug the outlet of the pump in order to test the same in this way. This they did, very much against their will, still insisting that the fault was with the pump. The pump was, of course, provided with a safety valve and the gage was connected with the pump and not with the piping. The gage read to 6,000 pounds to the square inch, and immediately upon starting the pump with the piping plugged, the pointer on the gage went around against the pin, showing we had something over 6,000 pounds pressure to the square inch, and the safety valve commenced to do business immediately in a way that gave us, who were near, a good shower bath before we could get out of range.

I gave the pump several tests in this way and found no trouble at all in getting 6,000 pounds pressure. This, of course, showed us that the fault was not in the pump, and upon going over the piping, fittings, etc., we found that the plug cock, which was apparently first-class in every respect, would hold up to about 400 pounds pressure; above this pressure the sides would spring in enough to allow the water to

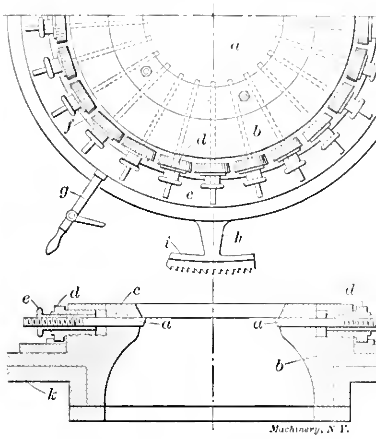
escape but would not stay permanently bent, returning to their normal condition upon the pressure being released and holding as tight as ever under ordinary pressures for which this valve was undoubtedly intended. W. P. Hunt.

Moline, Ill.

ROLL CORRUGATING DEVICE.

The device shown herewith is for the purpose of making more than one of the grooves in chilled or other rolls at once; and may be used in a planer in the same way as rigs usually employed for making one groove at a time.

With reference to the illustration the upper part shows an end view of half the device and the lower part a central cross section. The tools *a* are arranged in a circle in radial grooves



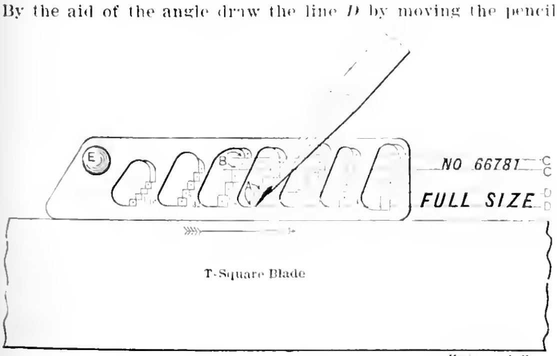
A German Rig for Corrugating Rolls.

in the casting *b*. These grooves are open above and are closed by the ring *c* which is bolted on the top of *b*. The tools are moved in or out in a radial direction by the gear pinions *d* which have long hubs threaded on the outside to fit the internal threads of the holes shown in the sectional view. All these pinions mesh with a toothed ring *f* which may be turned by the lever *g*. A movement of the lever *g* causes all the tools to travel out or in, according to the direction it is moved. The lever *h* is for the purpose of turning casting *b* which carries the tools through the necessary angle to bring them in the right position for grooving. The ratchet teeth *i* on lever *h* aré for the purpose of holding the lever in a fixed position when the tools are cutting. This is firmly attached by part *k* to the tool block of the planer on which the grooving is to be accomplished. The individual cutters are adjusted by means of bushings threaded on the inside to fit the threaded portion of the tools. They serve as nuts to adjust the tools in or out.

Hanover, Germany. Robert Grimshaw.

DRAFTSMAN'S DEVICE FOR DRAWING LETTER SPACE LINES.

This handy little tool I use for drawing letter space lines. To use it place it against the T-square blade as shown in the sketch with the pencil point on the paper at the lower angle *A*. By the aid of the angle draw the line *D* by moving the pencil



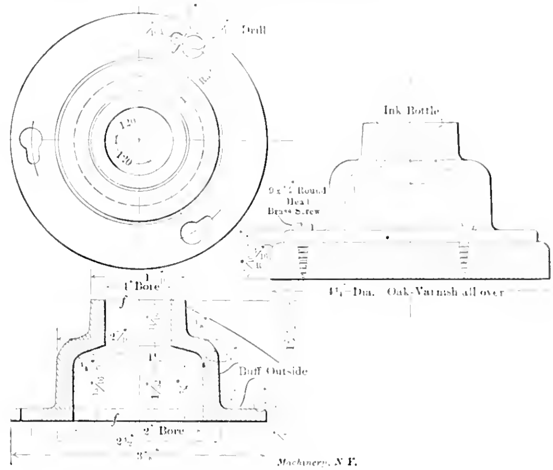
Template for Lettering Drawings.

and tool in the direction of the arrow, draw the line *D'* by the aid of the upper angle *A*, and the lines *D* and *D'* will be 5/32 inch apart. By placing the pencil point at the points *B* and following the same process the lines *C* and *C'* will be drawn 1/4 inch apart. *E* is a small knob or handle to pick it up by. The small rectangles with a dot in the center show where the notches were beveled off to let the pencil tilt. I made mine of gutta percha 1/16 inch thick, but it could be made of thin wood or of celluloid. F. W. Bach.

Ilion, N. Y.

AN INK BOTTLE HOLDER.

I noticed in the September issue a cut of an ink-bottle holder by Mr. D. E. Turnbull, which prompts me to forward you a print showing the type of ink-bottle holder used in this drafting room. This holder serves a twofold purpose, *i. e.*, to prevent spilling ink, and also as a paper weight, which explains the thickness of metal used in the construction. The wood screws are screwed down just tight enough to make a good sliding fit on the flange of brass case, and when it is desired to remove the bottle, the case is slipped around, until the



An Ink Bottle Holder.

heads of the screws come into the large diameter hole, when it can be removed from the oak bottom. Our experience with this during the last four years, has shown that it fills all requirements for which it was designed. W. O. Moody,

Chicago, Ill. Chief Draftsman Illinois Central R. R. Co.

SPEED OF BUFFING WHEELS AND GRINDSTONES.

Wood, leather covered	7,000 feet per minute
Walrus hide	8,000 feet per minute
Rag wheels	7,000 feet per minute
Hair brush wheels	12,000 feet per minute
Ohio stones	2,500 feet per minute
Huron stones	3,500 to 4,000 feet per minute

Howard, R. I. James A. Pratt.

RUST PREVENTIVES.

Caoutchouc oil has proven to be very efficient for preventing rust, and has been adopted by the German Army. It is applied by spreading over the surface of the metal with a piece of flannel in a very thin layer, and is allowed to dry. Such a coating will afford security against all atmospheric influences and is claimed will not show any cracks even under the microscope after a year's standing. To remove the coating the article has simply to be treated again with caoutchouc oil and then washed off after standing 12 to 24 hours.

All steel articles, tools, etc., can be perfectly preserved from rust by putting a lump of freshly-burnt lime in the drawer or case in which they are kept. If the articles are to be moved about (as a gun in its case, for instance) put the lime in a muslin bag. This method of preventing rust is especially valuable for preserving the characteristics of fractured specimens of iron or steel. In a moderately dry place the lime will

not need renewing for many years as it is capable of absorbing a large quantity of moisture. If the tools are in daily use they should be placed in a box nearly filled with thoroughly pulverized slaked lime; before using them rub well with a woolen cloth.

A. L. MONRAD.

New Haven, Conn.

INDEX FOR POCKETBOOKS.

Many have undoubtedly noticed the different forms in which the same information appears in the various engineers' pocketbooks, some of it complete and some of it less so. In the case of the tables most commonly referred to, the writer has found it convenient to cross index his pocket book as it were, and if working in Kent, for instance, and desiring a table of prime factors, one would see by reference to this index in the fly leaf that such a table could be found in Suplee or the pocketbook of the International Correspondence Schools. This index is shown herewith and may be of use to other readers of MACHINERY.

ROBERT S. BROWN.

New Britain, Conn.

Thus I am able to let the die remain in the bath, allowing them both to cool together and thereby obtaining results similar to those described by Mr. Shailor.

New York.

H. J. BACHMANN.

ENVELOPE SYSTEM FOR FILING DATA.

The arranging of data for ready reference has been to me quite a problem for some years past. First, I pasted my clippings in a book which was too small. Next, I got a well-made cloth-bound catalogue and removed some of the pages and took the clippings from the old book and pasted them into the new one. But I have decided now that the best method of keeping them is to have envelopes in which to put them, and have them under proper classification; for instance, all information concerning spur gearing is placed in one envelope. Bever, spiral and worm gearing each have a separate envelope. Belts and pulleys in one and ball and roller bearings in another, and so on. Small articles, such as taper pins, cotter pins, ratchets, Morse and B. & S. tapers are put into the same envelope.

	Kent.	Suplee.	International Correspondence School.	Practical Engineer.	Mechanical World.	Carnegie.	Pencoyd.	Jones & Laughlin.
Logarithms	6 place	5 place.	5 place.	5 place.	5 place.	5 place.	5 place.	1 to 100.
Hyperbolic Logarithms.	1 to 10 by 100ths. 10 to 50, 4 place.	1 to 10 by 100ths. 10 to 134, 7 place.		1.1 to 10 by 10ths. 10 to 20, 4 place.	1.1 to 10 by 10ths, 10 to 20, 4 place.			
Circumferences of Circles. Kent also has a table to 33 feet by inches in feet and inches. J. and L. ditto.	1 to 1000, 6 figures. 1 by 32ds, 5 figures. 6 by 16ths, 5 figures. 100 by 8ths, 6 figures.	1 to 1000, 6 figures.	1 by 16ths, 5 figures. 100 by 8ths, 6 figures.	100 by 10ths, 4 figures. 1 by 32ds, 4 place. 5 by 16ths, 5 figures. 100 by 8ths, 5 figures.	100 by 10ths, 4 figures. 1 by 32ds, 4 place. 6 by 16ths, 5 figures. 100 by 8ths, 5 figures.	1 to 1000, 6 figures. 12 by 16ths. 5 figures.	1 to 1000, 6 figures.	1 to 100, 4 figures. 3 by 16ths, 4 figures. 10 by 4ths, 4 figures. 10 by 20ths, 4 figures.
Areas of Circles. J. and L. have a table to 33 feet by inches in feet and inches.	1 to 1000, 2 place. 1 by 32ds, 5 place. 6 by 16ths, 3 place. 100 by 8ths, 1 place.	1 to 1000, 6 figures	1 by 16ths, 6 place. 100 by 8ths, 2 place.	100 by 10ths, 6 figures. 1 by 32ds, 4 place. 5 by 16ths, 5 figures. 100 by 8ths, 5 figures. .1 by .001, 7 place. 1 by .01, 4 place.	100 by 10ths, 6 figures. 1 by 32ds, 4 place. 5 by 16ths, 5 figures. 100 by 8ths, 5 figures. .1 by 001, 7 place 1 by .01, 4 place	1 to 1000. 6 figures. 12 by 16ths, 5 figures.	1 to 1000, 6 figures. 8 by 16ths, 5 figures. 100 by 8ths, 5 figures,	10 to 100, 1 place. 3 by 16ths, 4 figures. 10 by 4ths, 4 figures. 10 by 20ths, 4 figures.
Squares and Cubes Square Roots and Cube Roots *Squares only.	1 to 1600, 4 place. 1 by 20ths. 4 place.	1 to 1600, 7 place.		1 to 50 by 10ths, 2 and 3 place. 50 to 100. Roots all 4 place.	1 to 50 by 10ths, 2 and 3 place. 50 to 100. Roots all 4 place.	1 to 1000, 4 place. 12 by 16ths, 5 figures *	1 to 1000, 4 place.	up to 1250.
Higher Powers.	1st 9 powers of 1st 9 numbers.			4th powers from 1 to 10 by 8ths.	4th powers from 1 to 10 by 8ths.			
Prime factors.		1 to 9600.	1 to 1000					
Nat. Sines and Tang. *Sines only.	15 min., 5 figures.	1 min. 5 figures.	10 min., 4 place.	10 min.,* 4 place.	10 min.,* 4 place.	10 min., 5 place.	10 min., 5 place.	10 min., 4 place.
Log. Sines and Tang.	1 deg., 5 place.	1 min., 5 figures.						1 deg., 4 place.

An Index of the Tables in the Standard Pocketbooks.

HARDENING WITHOUT CRACKING.

Mr. Shailor's "Hardening Without Cracking" in the February issue is, in my humble opinion, the best and simplest method of die hardening that has been published in a long time. The "young fellows" (among them yours truly) must indeed be "thick" if they cannot catch the point he has so ably brought out. While the means employed by myself have been slightly different the end attained has been the same, *viz.*: Not allowing the die to become cold in the bath. I simply bring my pail of water to a temperature of about 80 degrees and plunge the die, thereby raising the temperature of the water to about 130-150 degrees or just too hot to bear the hand.

In this way the subject wanted can be located in a short time, and all I have upon any one subject (except that in text books) is found together. Heretofore, when placed in book form, different articles upon the one subject would be scattered throughout the book and much time lost in hunting for them. Another disadvantage with the book was that ofttimes there would appear information on each side of the clipping and in order to preserve each it would be necessary to fold over an edge and paste it into the book, but this crease would soon break open and cause more trouble.

Draftsmen to whom I have shown my method consider it to be well adapted. The envelopes are 5 x 8 inches, made of

strong manila paper. I use twenty-five envelopes, make two bundles of them and keep them together with elastic bands.

Bridgeport, Conn. C. E. JOSSELYN.

BACKING-OFF SPRING AND BUTTON DIES.

Some time ago I had occasion to make a number of special button and spring dies for screw machines of the form shown in Figs. 2 and 3; the puzzle was how to back the dies off or give them lead for the first threads on the cutting end. After trying several devices, I finally hit on the tool shown in Fig. 1,

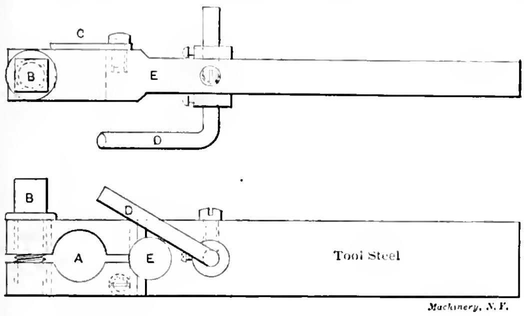


Fig. 1. Holder for the Dies.

which is made of tool steel and spring tempered at E. The dies of the spring style were inserted at A and clamped by the screw B, making sure that they were back against the stop C. The lever D was used as a stop being engaged with the flutes on the dies. I used this tool in the toolpost of the lathe, setting it a slight angle, if necessary, according to the lead or taper desired. The reamer countersink, Fig. 5, was held in

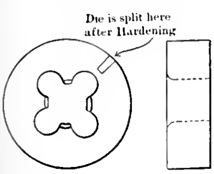


Fig. 2. Button Die.

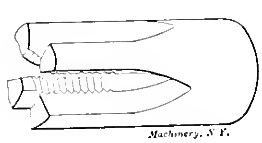


Fig. 3. Spring Die.

the chuck. A stop was clamped on the lathe bed and another on the cross feed of the lathe carriage, so that the travel in both directions was fixed.

For backing off button dies I used the bushing shown in Fig. 4, and for spring dies too large to go into the holder plugs were used which fitted the clearance hole in the dies, the plugs being clamped in the holder the same as the smaller spring dies. Although this tool may seem a rather peculiar

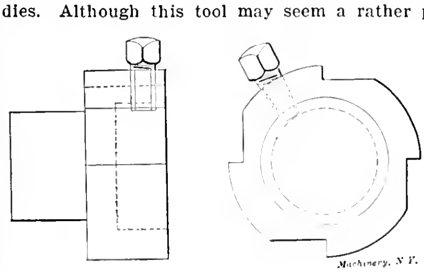


Fig. 4. Holder for Spring Dies.

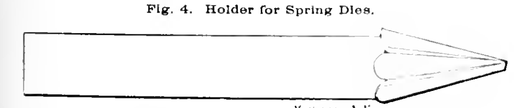


Fig. 5. Tool used for Backing-off.

device for backing off dies, it is away ahead of the file, and is just as good as special machines designed for the purpose. It will be found to effect a great saving, especially when one has no machine for the purpose; it is very easy to set, and in changing the dies one is simply taken out and another put in place without moving the tool or disturbing any of the adjustments. I generally smooth the dies up with a small half-round file after backing off in order to insure a keen cutting edge. For long threads I give the dies about four or five threads lead when they are not expected to cut up to a shoulder. JOHN S. SCOTT.

Lowell, Mass.

THICKNESS OF CUTTERS FOR TAPS AND CHUCKING REAMERS.

In selecting half-round milling cutters for taps, and chucking reamers, the following formula will give satisfaction in determining the proper thickness to be used on the fluting:

$$T = \frac{8\,D}{3\,A}$$

T = thickness of cutter.
D = diameter of tap or reamer.
A = number of flutes.

To illustrate, suppose we wish to cut a ½-inch tap, having four flutes. Then we have $\frac{8 \times ½}{3 \times 4} = 1/3 = 0.333$ inch for the thickness of cutter. The thickness of a half-round cutter for cutting a twist drill, will be about 7/9 the diameter of the drill.

J. A. P.

* * *

One of the perplexing problems of vehicle propulsion has been to devise some practical form of motor-driven sleigh for traveling on snow and ice. The usual type of experimental machine in this direction has been some form of the ordinary sleigh with a spiked traction wheel suspended so as to dig into the snow or ice and furnish the propelling force. It is a somewhat curious fact that the screw principle of propulsion should not have been developed for this purpose long ago. In the sleigh we have an example of the most primitive vehicle, being simply a pair of curved runners attached to and supporting a body. It is, however, one that offers very little resistance to motion because of the very slight coefficient of friction of snow and ice; in fact, the resistance of the sleigh on a good track is phenomenally low. One pair of horses can draw enormous loads as has been proven many times in lumber woods, loads of logs weighing 30 or 40 tons having been hauled by a team, where the conditions were favorable. For this very reason the screw system of propulsion would be working under the most favorable conditions, for the principal retarding factor of the screw is its friction, being as it is, an example of "wedge" action. If the runners were made in the form of screws or helices of considerable pitch and these were driven by power it would seem that such a "sleigh" should offer fairly small resistance to motion and should be quite efficient in operation. The revolving screws would tend to climb on top of the snow, and a momentary stoppage would not break the traction hold as is the invariable tendency with the spiked wheel tractor. It is of course quite easy now to make the suggestion, inasmuch as the principle has already been tried out and found to be fairly successful, as was noted in a recent issue of MACHINERY. But, the point to be made is that a thorough analysis of the subject should have pointed out such a system of propulsion long ago. Perhaps the habit of thorough analysis of any subject is one that very few people possess. The born inventor certainly does not have it. He has a way of jumping at conclusions—generally he jumps wrong, but sometimes he hits it all right.

* * *

The Pennsylvania Railroad Motive Power Engineering Association was organized March 6, 1906, by members of the mechanical engineer's office at Altoona, Pa., for the purpose of presenting papers and holding discussions on engineering subjects for mutual development and enlightenment. It is the intention to choose such subjects as are of general engineering interest, and also those which have a direct bearing on work in which the members are engaged. As indicated by the name, membership is limited to employees of the Pennsylvania Railroad and is still further restricted to all persons engaged in engineering work. The officers are C. E. Barba, president; R. N. Kennington, secretary; G. Peterson, secretary, and U. S. Drayer, treasurer. At the first meeting Mr. A. S. Vogt presented a paper "Locomotives and Cars."

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CHALK AS A LUBRICANT FOR LATHE CENTERS.

Chalk will prevent the centers of a piece being turned in the lathe, from cutting and squeaking. C. P. L.

DETERMINATION OF PROPER AMOUNT OF SALT IN HARDENING BATH.

It is common practice to use salt in a hardening bath; put enough in so the mixture will float a potato and your bath is about the right density.

Howard, R. I. JAMES A. PRATT.

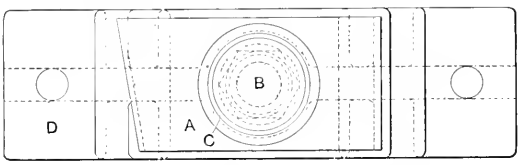
SALT BATH FOR HEATING.

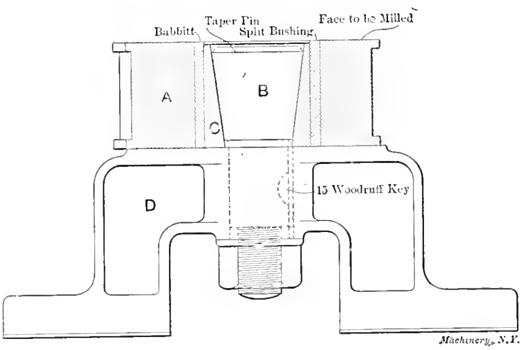
A salt bath is a convenient and satisfactory substitute for lead, when heating articles for hardening or annealing. Fill a receptacle with fine salt, place the article or articles in it and bring to desired heat; the subsequent treatment is same as for any other method of heating. JAMES A. PRATT.

Howard, R. I.

ROD BRASS FACING FIXTURE.

The cut shows a fixture for facing the sides of a certain type of connecting-rod box, either on the milling machine or engine lathe. The fixture, *D*, is bolted to the table or face-plate, as





the case may be; the boxes are first babbitted as shown. A split taper bushing, *C*, is made to suit the hole in the box, and bored tapering to suit the pin, *B*, which is drawn in by the nut on the under side. I. N. QUIRE.

TO LAY OUT ANY ANGLE WITHOUT A PROTRACTOR.

To lay out any angle without a protractor or any other tool but a scale and dividers, strike an arc with a radius of 3.58 inches; then every 1-16 inch on the arc is almost exactly one degree. For most ordinary purposes a radius of 3 9-16 inches may be used, the error being only about 1 degree in 360.

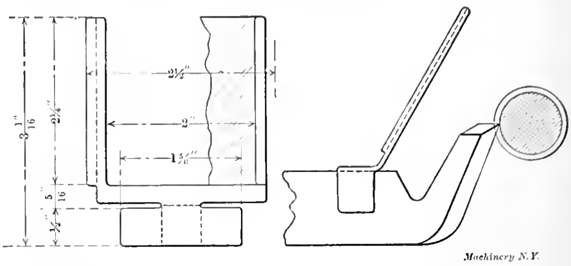
Stamford, Conn. EDGAR WERNER.

TO LOOSEN PASTED PAPER.

Sometimes it is desirable to loosen clippings that have been pasted in scrap-books, etc. To remove them by soaking in water is slow and is likely to injure the clipping or book unless extreme caution is employed. This trouble may be largely avoided by covering the face of the clipping with flour paste instead of water; the fresh paste soaks into the paper quickly and loosens the dried paste underneath. When the clipping is loosened the fresh and dried paste is readily washed off, of course. The same trick will be found to work well with old wall paper. The superior action of paste to water is due to its wetting the paper all over and having no tendency to run off. M. E. CANEK.

CHIP GUARD FOR LATHE TOOLS.

To protect the face from flying chips when turning in a lathe a chip guard may be applied to the tool as shown in the cut. It is made of brass, and bent as shown in the dotted



lines, a piece of mica, celluloid or wire gauze being pinched between the edges. This makes a more or less transparent guard and is superior to the common tin substitute for this reason. C. E. J.

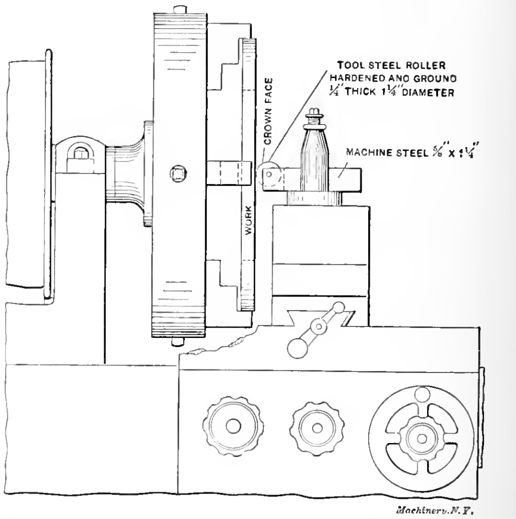
A SIMPLE WELDING FLUX.

The foreman of a large blacksmith shop gave me the following, which may be of use to your readers. We were speaking of the slag that is formed in the furnace, daily, when he said that he used it altogether as a flux for welding cast steel frames and other broken parts that occur in the repair of locomotives and other railroad work. All that is required is to pulverize it with a hammer when it is ready for use. It is applied as any other flux would be. WM. NEWTON.

Oneonta, N. Y.

TO TRUE UP WORK IN THE LATHE.

The cut shows a scheme for truing up any flat piece of work in the lathe chuck with accuracy and despatch. The roller tool is brought to bear on the work (which is lightly



caught by the jaws) with a light pressure, moving towards it as the work rotates, and in a few revolutions it will be found to run true. MARTIN WATROUS.

Ansonia, Conn.

* * *

The art of advertising has many followers and the tricks and devices employed are legion. A picture is given in a farm journal which is supposed to show a noted plow manufacturer plowing in a field on his farm, but to all intents and purposes the gentleman is posing for his picture, in the husky attitude of holding to the plow handles (his make) while the horses stand at rest!

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

183. TO FASTEN PAPER LABELS TO IRON OR STEEL.

Rub the surface over with an onion cut in half. Then apply the label with glue or paste. L. E. MUNCY.

Syracuse, N. Y.

184. LACQUERING EFFECT ON POLISHED STEEL.

Mutton suet burnt on a polished surface produces a brilliant black which is very lasting. H. T. MILLAR.

Manchester, Eng.

185. TO PREVENT EXPOSED IRON RUSTING.

To prevent iron, which is exposed to moisture, from rusting, paint over with a coat of Portland liquid cement. This is very satisfactory for posts which are set in the ground.

Howard, R. I. JAMES A. PRATT.

186. BRONZING FLUID FOR STEEL.

To obtain a light bronzing fluid use nitric acid, 6 parts; nitric ether, 5 parts; alcohol, 5 parts; muriate of iron, 5 parts. Mix thoroughly and then add 10 parts sulphate of copper dissolved in 50 parts of water. O. G.

187. TO KEEP STEEL TOOLS IN THEIR HANDLES.

To keep steel tools in their handles, fill the handle with powdered rosin and a little rotten stone. Heat the tang of the tool hot, and then push it down hard into the handle; when it is cold it will be firmly set. M. E. HOWE.

Worcester, Mass.

188. TO REMOVE GREASE STAINS FROM PAPERS, DRAWINGS, ETC.

Place sheets of blotting paper over and under the stained page, to protect the others. Lay powdered magnesia on the stain and under it; then press over the blotting paper with a hot iron. When the powder is shaken off, the stain is gone.

New Britain, Conn. F. L. ENGEL.

189. TO PRESERVE REFERENCE TABLES.

Reference tables are very convenient to use but soon get dirty and torn. To prevent this pour some lacquer in a shallow tray and dip the paper into it and hang it up to drain and dry. This not only makes the paper dirt-proof but toughens it as well. MILTON BURGESS.

Cleveland, O.

190. A CEMENT FOR MENDING RUBBER GOODS.

Dissolve raw gum rubber or caoutchouc in bisulphide of carbon for a number of days in a tightly stopped bottle until it has the consistency of a thick paste. Make the surfaces to be cemented clean and dry before applying, and press joint tightly together. L. E. MUNCY.

Syracuse, N. Y.

191. TO CEMENT EMERY CLOTH TO POLISHING DISK.

Apply quickly to the disk with a broad flat brush a coat of moderately thick shellac varnish. Lay on the emery cloth and place under a press at once. The shellac varnish must be clean and without lumps as these may not be pressed down to an even surface and so cause scratches in the work.

Neponset, Mass. OSCAR E. PERRIGO.

192. TO REMOVE STEEL CHIPS FROM JIGS AND THE LIKE

It is often very desirable to remove chips of steel from jigs and the like each time a new piece is inserted. An easy way to do this is to put a pound of caustic soda in a gallon of water and dip the jig in every time it is desired to remove the chips. F. PAVLIK, JR.

Winnetka, Ill.

193. SOLUTION FOR WRITING ON BLUEPRINTS.

In reply to the inquiry of D. C. T. in the December issue, for a solution for marking on blue-prints, would say the best I have tried is a very thick lime water. Have a good deal more lime than will dissolve and shake up the bottle just before using, and it will not spread. Possibly this solution could be colored with red ink, but as I prefer the white I have never tried it. G. V.

194. LUBRICANT FOR LATHE CENTERS.

I have tried many different kinds of lubricants for lathe centers and as yet I have found nothing equal to white lead mixed with sperm oil, with enough graphite added to give it a dark lead color. It can be mixed and kept in small tin boxes; add oil when necessary to keep it from getting too thick. S. C. S

195. SOLDERING ALLOYS.

I have used the following soldering alloys and can recommend them:

For copper with copper: Copper, 55; zinc, 40; tin, 5.
For copper with iron: Copper, 80; zinc, 16; tin, 4.
For brass: Copper, 45; zinc, 50; tin, 5.
For lead: Lead, 67; tin, 33.

Los Angeles, Cal. J. M. MENEGUS.

196. TO TOUGHEN AND SURFACE HARDEN CAST IRON.

To toughen and surface harden small cast iron machine parts, which are subjected to wear, such as small gears, cams, etc., heat to a dull red and quench in a saturated solution of cyanide of potash and water which should be kept as near boiling point as possible. This can be accomplished best by putting the solution in an iron pot near the fire in which the parts are being heated. J. B. V.

197. GLUES WHICH RESIST MOISTURE.

A glue cement that resists moisture is made by mixing with the least possible quantity of water 1 part glue, 1 part rosin and 1/4 part red ochre.

Another glue which resists moisture is made of one pint glue melted in two quarts skimmed milk. Add powdered chalk to make it stronger.

A marine glue is made of one part of india rubber, 12 parts naphtha. Heat gently, mix and add 20 parts of powdered shellac. Pour out on a slab to cool. When used it has to be heated to about 250 degrees F. A. L. MONRAD.

New Haven, Conn.

198. TO CLEAN JEWELRY, SILVERWARE AND METALS.

The following receipt is one that not all jewelers know. It can also be used to clean the hands on special occasions; it will not crack the hands if vaseline is rubbed in well immediately after rinsing them off in water:

Make a saturated solution of cyanide of potassium by taking a quantity of water, and dissolving the cyanide in it, until no more cyanide will dissolve. Dip the article in this solution until the dirt is eaten off (this takes but a short time) then rinse off in hot water, and dry in boxwood sawdust. The article will then look better than when new.

St. Paul, Minn. PARKE B. SHEE.

199. TO PRODUCE BROWN FINISH ON STEEL.

To produce the rich brown finish that is commonly used on large guns use sulphate of copper, 1 ounce; sweet spirits nitre, 1 ounce; distilled water, 1 pint.

Four coats are applied, allow several hours to elapse between the successive coats, brushing after each if necessary. After the last coat, rub down hard and allow to dry 24 hours. This gives a reddish-brown color without gloss. By adding arsenic to the mixture before last coat a deeper hue is obtained. The polish is obtained by means of a mixture of boiled oil, beeswax, and turpentine, comparatively thick. Rub in well with cotton cloth and finally with the palm of the hand. R. P. PERRY.

* * *

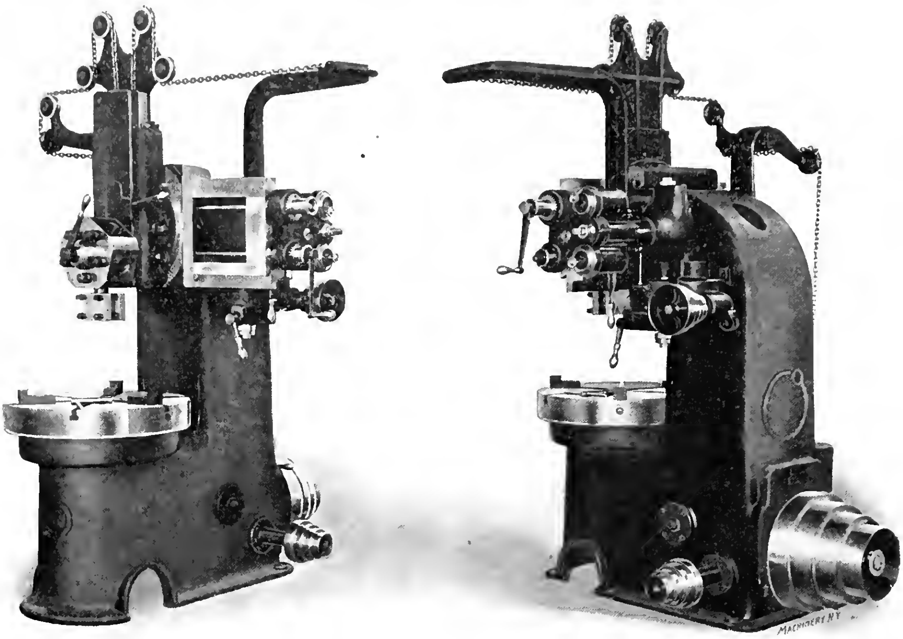
A convenient rule for approximating the time required for turning locomotive tires with the best modern driving-wheel lathes is to allow one minute per inch of diameter. For example, a 60-inch tire would require about 60 minutes for the actual turning according to this rule, the time of setting and removal from the lathe being additional.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

GISHOLT VERTICAL BORING MACHINE.

In the accompanying halftone is shown a vertical boring mill developed by the Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. The tool is designed to be a thoroughly accurate and serviceable one, but at the same time to be sold at a moderate cost. With this end in view changes in feed and speed are made largely by cone-pulleys and shifting belts. The headstock is driven by means of a four-step cone. A two-speed countershaft and back gearing operated by a positive



Gisholt Thirty-inch Vertical Boring Mill.

clutch give sixteen speeds in all. All gears are encased, and all those subject to heavy duty are of steel. The machine may be motor-driven if desired. There are eight feeds ranging from 1-64 to ¼ of an inch per revolution. Any feed, vertical, horizontal or angular, may be operated by hand or power. Micrometer index dials reading to 0.001 inch are provided for all feeds, together with an automatic tripping device which will always stop the feed positively at the end of its traverse. The table is furnished in two styles, either as a universal and combination chuck fitted with three movable jaws and nine radial T-slots, or a plain faceplate with twelve radial slots. The turret is five-faced and has 2¼-inch holes. The height under the rail is 17½ inches. The floor space is 63 x 63 inches. Extreme swing, 34 inches, diameter of table, 28 inches; the total gearing ratio is 20½ to 1. The machine weighs about 5,000 pounds.

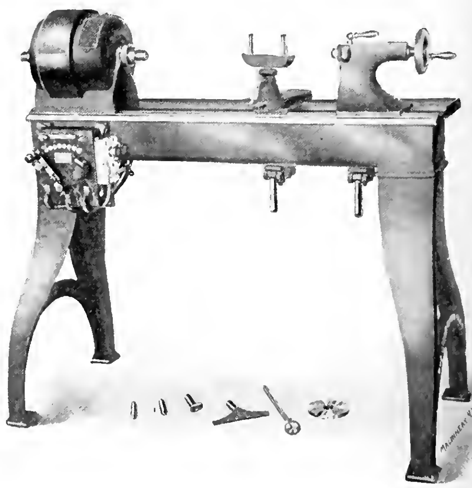
GARVIN MOTOR-DRIVEN SPEED LATHE.

The accompanying illustration shows a motor-driven spinning or hand lathe recently brought out by the Garvin Machine Co., Spring and Varick Sts., New York City. The headstock is fitted with a 1 horsepower motor, direct connected with the hollow steel taper spindle, of standard size, running in gun-metal boxes. The motor is equipped with a Cutler-Hammer controller for a 110-volt current, giving a range of speeds between 800 to 2,000 revolutions per minute.

The machine itself is the regular standard 12-inch swing lathe, made by this company. The bed is wide and deep, and is closed top and bottom, except for a narrow slot for the binder bolts, and is ribbed internally to secure rigidity. The tool-rest and tailstock are bound by powerful cam-binders. A wooden shelf, supported by iron brackets, extends the whole length of the bed at the back, and is convenient for holding work and tools. This lathe is made in 10-inch, 12-inch and 15-inch swing, and can be furnished with wheel, lever, or combination tailstocks, as may be desired. It is a high-grade tool, and adapted to toolmakers' use.

REVERSIBLE TAP HOLDER AND SAFETY CLUTCH.

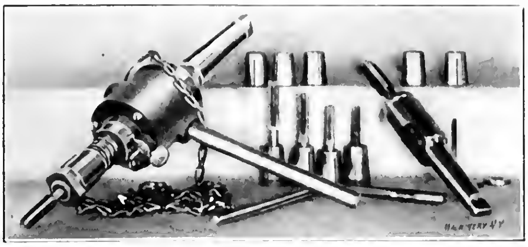
The Mutual Mfg. Co., Bridgeport, Conn., have placed on the market the tapping attachment shown in the cut. This attachment is of the type which does not require the spindle or the drill press, or other macine, to be reversed. When the tap has reached the required depth it is backed out by the mechanism enclosed in the body of the attachment. The forward motion is transmitted directly from the spindle to the tap by a friction drive. The thumbscrew at the lower end of the case is used to regulate the distance to which the pin shown projects from the casing. This pin engages a similar one in the revolving collar on the tapping spindle. When the tap has entered the hole to such a depth that these two pins are out of engagement with each other the tapping spindle is reversed by a friction clutch, and the tap backs out. The attachment may be prevented from rotating either by the handle shown or by attaching the chain to some stationary part of the machine, whichever way is most convenient. The chuck in which



Garvin Motor-driven Speed Lathe.

the tap is held is shown separately at the right of the cut. A bushing is used which fits the shank of the tap, this bushing having a tapered outside diameter which is fitted to the interior of a nut screwed into the chuck. This nut seats against a solid shoulder. The abutment for the rear

of the bushing, however, is formed by another adjustable nut at the rear, which may be tightened or loosened through the openings at the side. By turning this nut the bushing may be firmly gripped in place or may be held with so light a pressure that it can be revolved with the fingers. This provides an easily adjustable friction drive which may be tightened to such an extent as to carry the tool being used, without, at the same time, having strength enough to break it. This chuck is sold separately as well, for use with either straight or taper shank drills up to ½ inch in diameter.



A Reversible Tap Holder and Tools used with it.

CUTTER GRINDER ATTACHMENT FOR DRILL GRINDER.

The Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., as may be seen from Fig. 1, are applying a simple cutter and reamer grinder to their well-known "Yankee" drill grinder, thus making a combined machine which pretty well fills the requirements of a small tool room. The construction of the drill grinder is well-known, it being such that each drill, on account of the peculiar relation between the axis on which it oscillates and the angular V-shaped trough in which it is placed, determines its own position by its diameter, thus doing away with the necessity for any adjustment for the size of the drill.

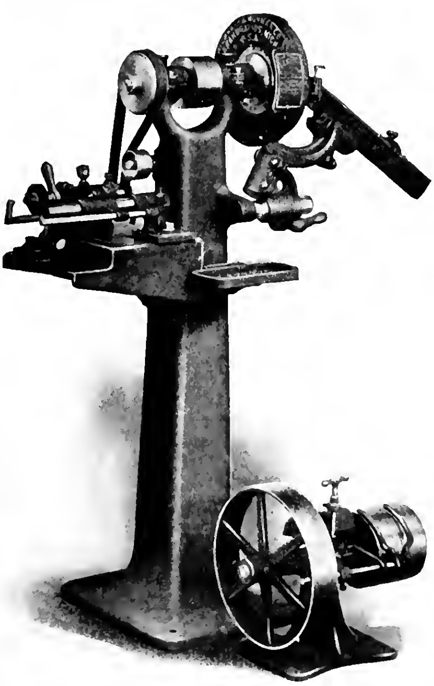


Fig. 1. Drill Grinder with Cutter Grinder Attached

The cutter grinder spindle carries a 1½-inch pulley for a 1-inch belt, and is driven from a 4¾-inch pulley on the drill grinder spindle. The spindle of the cutter grinder is hardened and ground and runs in an eccentric sleeve whose position may be altered by the handle shown, to adjust the emery wheel toward the cutter to be ground. The wheel used is 2½ inches in diameter with a ½-inch face. Fig. 2 shows the grinding of an angular mill in this device. The cutter is supported on a swiveled head on the carriage, this being adjustable to any angle. This same head is utilized for grinding the sides of face mills. Large straight and spiral milling cutters and shell reamers are supported on the main bar on which the swivel head travels. Cutters in which the diameter of the hole is so small that they cannot be ground in this way can be supported on an arbor between centers which are provided for such work as this and for grinding taper reamers, etc. The base of the device is provided with T-slots so placed that the chief parts can be adjusted in such relation to each other as to bring the various cutters and reamers in proper position in relation to the emery wheel.

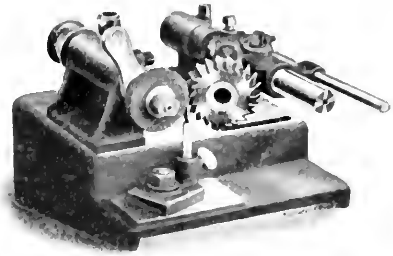


Fig. 2. Cutter Grinder Set for Sharpening Angle Cutter.

THE HEALD ROTARY SURFACE GRINDER.

The Heald Machine Co., Worcester, Mass., have been making improvements in their rotary surface grinder. To meet the requirements for heavier and more accurate work, the machine has been supplied with water guards around the grinding wheel, and a rectangular box about the chuck which takes care of the water used in grinding. A water tank will be noticed at the rear of the pedestal. This is provided with a centrifugal pump on a vertical axis to furnish water to the wheel. The machine as shown, arranged for wet grinding, is well adapted to finishing hardened steel parts, thrust collars, slitting saws, and case-hardened pieces, since the use of water guards against drawing the temper of the work, and, in the case of thin pieces, overcomes the tendency to spring or warp out of shape from unequal heating.

The action of this machine is readily apparent. The spindle with its magnetic chuck may be revolved at a suitable rate of speed for the work in hand. The rotating grinding wheel

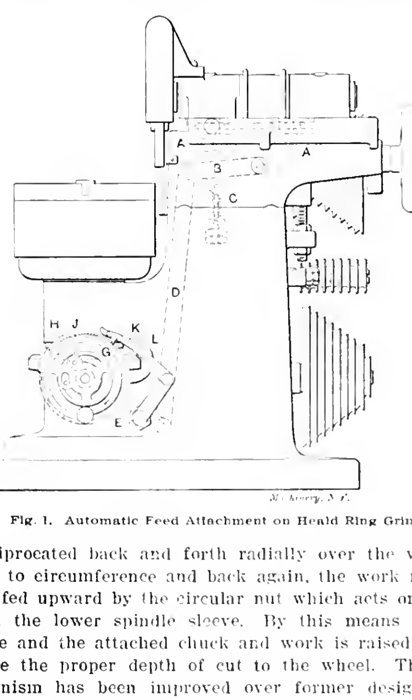


Fig. 1. Automatic Feed Attachment on Heald Ring Grinder.

is reciprocated back and forth radially over the work from center to circumference and back again, the work meanwhile being fed upward by the circular nut which acts on a thread cut in the lower spindle sleeve. By this means the whole spindle and the attached chuck and work is raised vertically to give the proper depth of cut to the wheel. The feeding mechanism has been improved over former designs in the

machine shown in the cut, by adding a hand wheel and bevel gears to allow a finer and more convenient adjustment. An automatic vertical feed will be provided for use in connection with this machine, if desired. Where there is much stock to be removed this attachment renders the machine self operative, allowing it to grind continuously until the desired thickness is obtained, at which point the feed is thrown out and the machine is ready for a new piece of work.

The operation of this automatic vertical feed will be readily understood from Fig. 1. The reciprocating head which carries the emery wheel is provided with a slot in which are fastened dogs *A A*. These dogs actuate lever *B* by striking the cam surface formed on its upper side. After the machine is set for a given stroke, dogs *A A* may be so adjusted as to depress this lever at each end of the movement of the head to any depth desired, depending on their position. A spring *C*, whose tension is adjustable, returns the lever to its previous position as soon as the dogs start on their return travel. The intermittent movement of lever *B* is transferred to rock shaft *E* through link *D*. To an arm pivoted on this rock shaft is attached pawl *L*, which has a hardened tooth engaging with teeth formed in the periphery of ratchet wheel *G*. It is evident that this mechanism provides for a movement of wheel *G* in the direction of the arrow at the end of each stroke of the head, this movement being adjustable at the desire of the

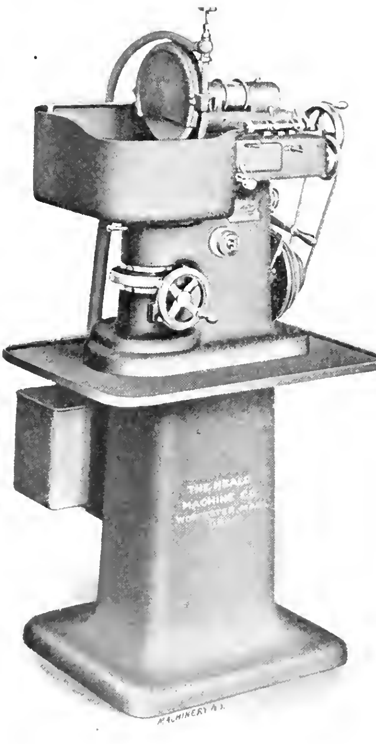


Fig. 2. Heald Ring Grinder arranged for Wet Grinding.

operator. Wheel *G*, which takes the place of the hand wheel shown in Fig. 2, is connected by gears with nut *K*, which raises or lowers the spindle and feeds the work toward or away from the emery wheel. To stop the feed when the work has been ground to the proper thickness a guard *H* is provided, mounted on a swinging sector which may be clamped at any desired position in relation to the periphery of the ratchet wheel *G*, by means of a clamp screw *J*. When guard *H*, traveling with wheel *G*, has been brought by the pawl *L* to such position that the teeth under the pawl are covered, feeding is of course stopped. The spindle may then be lowered again while a new piece of work is inserted.

DRAWING-BOARD STAND.

A neat folding and adjustable metal trestle for holding drawing boards has been brought out by Williams, Brown & Earl, Philadelphia. This trestle, in connection with a drawing board, makes a convenient draftsman's table, adjustable to any desired height and so braced that it is rigid and firm. It can be used for holding drawing boards of any size and can

Fig. 1. Adjustable Folding Drawing Stand.

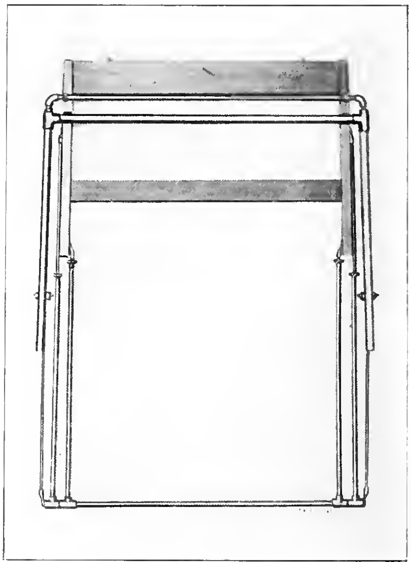


Fig. 2. Drawing Stand Folded.

be folded into small compass, making it convenient for use where a drawing table is to be transported It is also well adapted for home use because of the small space occupied when folded.

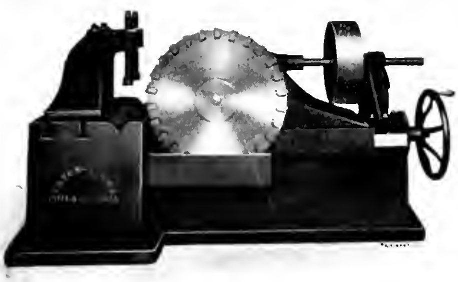
STEEL FOUNDRY COLD SAWING MACHINE.

The Newton Machine Tool Works, Philadelphia, Pa., are the builders of the saw shown in the engraving. It is known as their No. 0 steel foundry cold saw cutting-off machine and, as shown, is arranged for belt drive. The spindle is mounted on a ram which has an automatic feed of 18 inches in length variable through friction disks. An in-and-out hand adjustment and power quick return are provided. The saw is 32 inches in diameter and is of the Taylor-Newbold inserted tooth design, and is driven through spur gearing by a worm and worm wheel of steep pitch. An adjustable work table is provided which allows the work to be clamped in place and afterward adjusted to bring the saw to the proper point for action. It has capacity for cutting gates and risers up to 9 inches in diameter. One of the users of the machine reports that it has been cutting off 8-inch by 8-inch sink heads in eight minutes.

THE ESPEN-LUCAS COLD SAW CUTTING-OFF MACHINE.

The machine illustrated below is one which has been tried out in actual practice and has given very satisfactory results. It was especially designed to drive a saw made with inserted teeth of high-speed steel and is so constructed that it has ample power and stability to drive a saw of this description up to its limit of capacity. The intention has been, in fact, to give the machine sufficient strength to allow it to meet such demands as improvements in saws and tool steel may require of it in the future.

The capacity of the machine is such that it easily handles 9-inch round steel. The saw is driven by a hammered crucible steel worm and phosphor bronze worm wheel, through compound gearing of hammered crucible steel cut from the solid. A variable automatic feed is provided, controlled by an automatic stop which may be set for any depth of cut. The work



Espen-Lucas Cold Saw Cutting-off Machine.

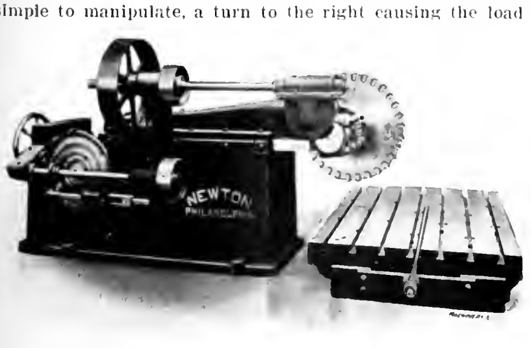
may be held on any part of the platen at any angle by means of swiveled clamps provided with the machine. For special work, these clamps may be removed and any suitable devices used for holding the work, thus providing for every possible contingency. The machine is a product of the Espen-Lucas Machine Works, Broad and Noble Sts., Philadelphia, Pa.

ERASING FLUID FOR WATERPROOF INK.

The Inkoff Mfg. Co., 314 Madison Ave., New York, manufactures the erasing fluid "Inkoff" from which the firm takes its name. A sample which has been tried in this office appears to give very good results on tracing cloth. It can be used repeatedly on the same surface without injuring the cloth and it dries very quickly. It is said to contain no acids injurious to the hands or tracing cloth. It acts as a solvent, being successful with waterproof inks as well as with ordinary black ink.

IMPROVEMENTS IN AN ELECTRIC HOIST.

The electric hoist manufactured by the Yale & Towne Mfg. Co., 9-15 Murray St., New York, has recently been improved in several particulars. As ordinarily constructed, it is intended to be suspended by a single swiveling hook from any support that will carry a load, such as a beam, a shear pole or I-bolt on a trolley in the same manner that an ordinary chain block is suspended. This enables the hoist to make a dragging lift at an angle of 45 degrees, and so cover a large floor area. The controller, which is a part of the hoist, is simple to manipulate, a turn to the right causing the load to



Newton Steel Foundry Cold Saw.

be raised and a turn to the left to be lowered. When released the hoist stops. If the operator fails to release the controller an automatic stop opens the circuit, and should a fuse blow out the current would be shut off and the load safely held.

One of the improvements, shown in Fig. 2, consists of turntable collector rings which permit the hoist to swivel continu-

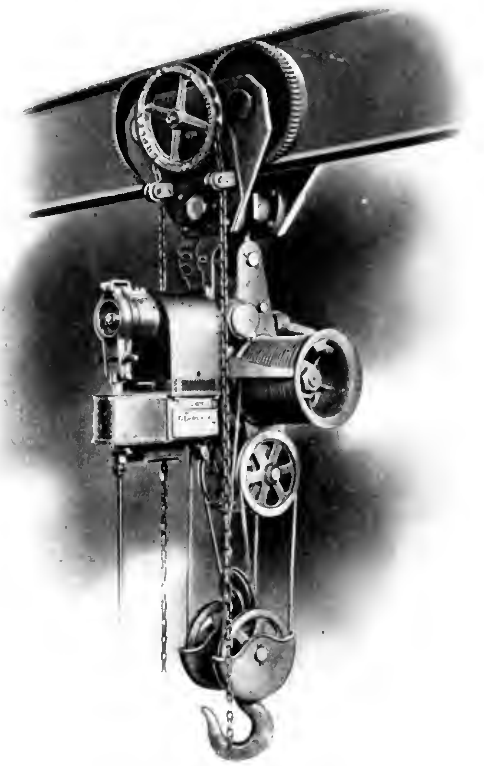


Fig. 1. Yale & Towne Electric Hoist.

ously in one direction without twisting up the leads. The two wires leading to the hoist pass into the top hook and down through its hollow shank to insulated collector rings which are fast to the hook. The hoist is hung from a yoke supported by the hook, which is free to swivel about the shank of the hook and is carried by a ball bearing. Contact between the two collector rings and brushes, as shown in the engraving, conducts the current to motor.

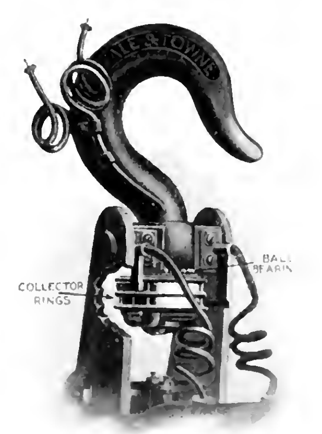


Fig. 2. Collector Rings for Swivel Hook.

In Fig. 1 the hoist has a clevis connection with a geared trolley, which allows the hoist to swing in any direction when raising a load out of line with the center of support, thus enabling it to adjust itself in some degree to an angular lift.

While heretofore these hoists have been constructed for use with wire rope, they are now manufactured with chain lift if desired, and as the chain is not wound on a drum like the rope, the height of the lift with this type is not limited. It is also adapted to the handling of ingots or other heated material where a wire rope hoist might fail, on account of the damaging effect of high temperatures upon such rope.

A Convention Group, not taken for publication.

MACHINE TOOL BUILDERS' CONVENTION.

The spring meeting cf the National Machine Tool Builders' Association, which was held at Atlantic City May 1 and 2, was the most largely attended of any meeting that has been held, and the presence of many ladies at the hotel added an attractive feature to the gatherings. The progress of the association was shown by the addition of six new and important firms as members, viz: The Niles-Bement-Pond Co., Cincinnati Machine Tool Co., Cincinnati; W. F. & John Barnes Co., Rockford, Ill.; Rocktord Machine Tool Co., Rockford, Ill.; Mechanics' Machine Co., Rockford, Ill., and Dwight Slate Machine Co., Hartford, Conn.

One of the principal events was the meeting of the various committees comprising manufacturers of the different lines of machine tools, to discuss the matter of an increase in price. The planer and shaper sections, as well as the upright drill makers, had already voted an increase of 5 per cent. The lathe manufacturers made a similar advance, this being, of course, in addition to that decided soon after the New York meeting in December, giving a total increase of 10 per cent. No reports were received from the manufacturers of radial drills, milling machines, boring mills and sensitive drills.

Mr. E. P. Bullard, Jr., read a paper on the apprenticeship system in which the relation of this question to the trade was considered in all its bearings. This paper, which is a very suggestive one, we hope to reproduce in the July issue of MACHINERY. Another matter which was discussed, related to the investigation of the subject of obtaining the cost of production of machine tools. Ignorance on this point on the part of many manufacturers has been a disturbing factor to the trade in times past. When a machine tool builder has somewhat hazy ideas on this subject, although he may be running his business profitably as a whole, he is yet almost certain to assign too large a share of the cost of manufacture to one part of his line and too small a share to the remainder. Under these circumstances there will often be some tools which he is prepared to sell in competition with other manufacturers for prices considerably below the minimum cost of manufacture. This action demoralizes business, besides being in the long run inimical to the interests of the firm which makes the mistake. A committee composed of the following members was appointed to investigate this matter of cost accounting: F. A. Geier, E. P. Bullard, Jr., and C. H. Alvord. It is hoped that this committee will be able to recommend a standard method of cost accounting which will put all the builders in the field on the same basis, and eliminate the possibility of any one selling machinery unknowingly at a price below the cost of production. It was voted to hold the next meeting, which will be the annual meeting, in New York City in October. The executive committee will decide later as to the headquarters and date.

* * *

THE FATE OF THE METRIC BILL.

As most of our readers who have been interested in the Littauer metric bill know, this legislation has received its quietus, the House committee having voted not to report it favorably, thus putting an end to the metric agitation for this session at least, and we hope for a number of years. This result was accomplished after a campaign of unusual vigor and persistence, and is a cause for congratulation among machinery manufacturers.

* * *

PERSONAL.

Mr. C. Frank Schwep has been appointed general purchasing agent of the Ingersoll-Rand Co., with headquarters at 11 Broadway, New York. Mr. Schwep has been at the head of the purchasing department of the Ingersoll-Sergeant Drill Co. for the past thirteen years, being located at the shops of Easton, Pa., and Phillipsburg, N. J.

The Baush Machine Tool Co., Springfield, Mass., at the annual meeting held on April 23 made the following changes in the list of officers of the company. Mr. Edward A. Appleton was elected president to succeed Mr. H. R. Dalton, Jr., who resigned. Mr. G. Frank Adams was elected vice-president; Mr. C. J. Wetsel was elected treasurer and general manager, and F. E. Bocorselski was elected superintendent.

Joseph V. Woodworth, a contributor to our columns, and author of several works on modern machine shop practice, has transferred his office to 383 Pearl St., Brooklyn, N. Y., where, as a consulting expert, he is prepared to advise, either personally or through correspondence, along the lines of interchangeable manufacturing, sheet metal working, steel treatment, and the reduction of manufacturing costs.

Eugene N. Foss, known to our readers as the head of the B. F. Sturtevant Co. and the Becker-Brainard Milling Machine Co., is now in Europe. He has gone abroad partly for rest, but particularly to meet some of the leading statesmen and merchants of England and the continent, in connection with his studies of certain economic questions in their relation to the foreign trade of the United States.

* * *

OBITUARY.

Henry C. Williamson, of Michigan City, Ind., died April 29, aged 70 years. He was mechanical superintendent and engineer of the Haskell & Barker Car Works of that place.

George E. Dana died at his home in Syracuse, N. Y., April 18, 1906. He was born in Lowell, Mass., in 1834, and graduated from Harvard College in 1854. For a long period of years he had been connected with the Whitman & Barnes Mfg. Co., Chicago, having been secretary of the corporation, then vice-president, and from 1889 to 1902 president. He was then elected chairman of the board of directors and held that position at the time of his death. Mr. Dana was also a director in two banks in Syracuse, and was financially interested in several other enterprises.

* * *

FRESH FROM THE PRESS.

STRUCTURAL STEEL WORK. Published by Chas. Griffin & Co., London, England, and the J. B. Lippincott Co., Philadelphia, Pa. 248 pages, illustrated. Price $3.50.

This treatise gives an elementary discussion of structural steel work for civil and mechanical engineers and architects who have to design and superintend the erection of steel structures of various kinds; but little attention is given to the mathematics of steel work, the matter being largely descriptive. The book is divided into two parts, the first taking up practical designing, and the second shop work. In the first part there is a discussion of the factors governing the design of structures and specifications, and the inspecting and testing of material and estimating are considered. In the second part, the equipment and method of producing work economically in the different departments of a structural steel shop is taken up, the various chapter headings being "The Template Shop," "The Girder Shop," "The Smith Shop," "General Equipment," besides chapters treating of miscellaneous matters.

HEAT AND LIGHT FROM MUNICIPAL AND OTHER WASTE. By Jos. G. Branch. 305 pages 5½ x 7¾ inches and 56 cuts. Pubilshed by Wm. H. O'Brien Printing and Publishing Co., St. Louis, Mo. Price $3.00.

This book is written for municipalities, and engineers concerned with the economic disposal of waste material. The importance of disposal of municipal waste in a way that shall not be offensive to the

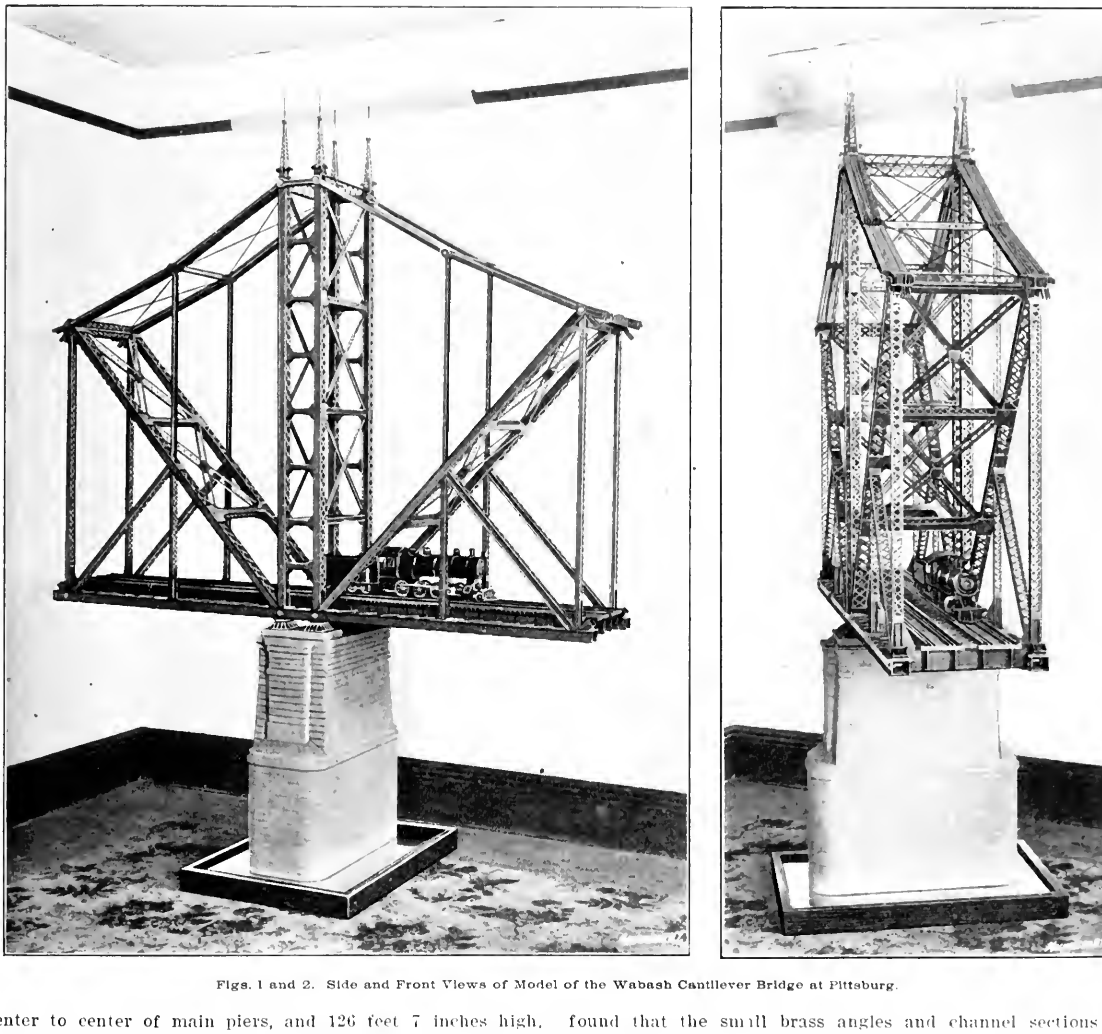
MACHINERY.

July, 1906.

THE CONSTRUCTION OF A BRIDGE MODEL.

JARVIS A. MARIKLE.

THE model shown in the halftones, Figs. 1 and 2, is of a portion of the Wabash Pittsburg Terminal Railway Co.'s double track cantilever bridge, over the Monongahela River at Pittsburg, Pa. This bridge was designed by Messrs. Boller & Hodge, consulting engineers, New York, and was built and erected by the American Bridge Co. It is 1,504 feet long, center to center of anchor piers, 812 feet, center to center of main piers, and 126 feet 7 inches high, center to center of pins at the tower, total weight of steel, 7,000 tons; total cost including foundation and masonry, $1,000,000.



Figs. 1 and 2. Side and Front Views of Model of the Wabash Cantilever Bridge at Pittsburg.

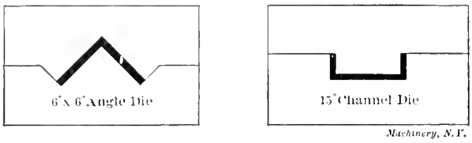
The model is of the north shore pier and two panels of the superstructure either side of the tower representing about 172 feet of the bridge and it shows the typical construction of the whole span. It is about 6 feet long, and 7 feet 6 inches high, being made to a scale of ¾ inch to the foot. The inclined and vertical web members are box sections, being built up of L's and plates riveted together and latticed on either side with flat bars. The lower chords are also box sections of similar construction. The wind bracing is of both box and I-section form, the I-section being composed of four L's latticed together with small flat bars. The floor system is of built beams, or plate girders, composed of 4 L's and a web plate riveted together in the form of an I. The girders which run transversely are called floor beams, and support the longitudinal girders or stringers which carry the ties. The main web members and chords of the whole structure are pinned together with steel pins.

Prior to starting the construction of this model, it was found that the small brass angles and channel sections of the sizes required for the work could not be obtained, which necessitated the making of dies with which to draw them. These dies were filed out of 3/16-inch steel, and made in two parts, being backed off on the side through which the brass was entered. It took six sets of dies to turn out the different sizes of material.

In drawing the different sections the dies, Figs. 3 and 4, were held in a bench vise, and brass ribbon of the proper width was shaped into form by hand, and forced through the die far enough to attach a come-along, to which was hitched a small tackle. By this means, the different shapes were drawn in lengths that would cut up economically, usually from 7 to 8 feet long.

One great difficulty experienced, was getting the brass rib-

bon in stock of proper widths and thicknesses, out of which to make the different sections; and it was practically for this reason the model was made to the scale of 3/8-inch to the foot, each 1/32 inch equalling 1 inch at that scale. For instance, 3/8-inch ribbon (12/32) made the 6 x 6-inch L. The web plates were also made of brass ribbon but of a heavier gage than that used for L's, the width ranging from 9/16 to 1 1/16 inch, and in several instances when the right width could not be obtained, it was necessary to shear the plate to width by hand. This was done by scratching a line on the ribbon with a scratch gage, and then with shears cutting off 1/16 inch or 1/8 inch as might be required from strips running in lengths from 20 to 30 feet. These plates in every



Figs. 3 and 4. Drawing Angles and Channels from Strip Brass.

instance had to be peined on the edge to bring them to a straight line, as the shearing caused them to have a lateral wind.

Having sufficient material prepared to start the four main posts, the next thing taken up was the riveting together of L's and plates in the form of channels. On account of the wavy condition in which the L's came from the dies, it was apparent there would be trouble in getting them riveted to the plates straight and true, and to accomplish this, the following scheme was devised. Three strips of wood about five feet long were fastened to a bench, and on one of the strips the pin centers of the member was accurately laid off. Between these centers, the strip was divided into spaces of about 1 inch; these were for the location of the rivets which were to hold the L's and plates together. The L's were now straightened by hand and forced into the slots, thus being held true to line.

The web plate which had previously had gage lines scratched on it the whole length, was laid on top of the L's,

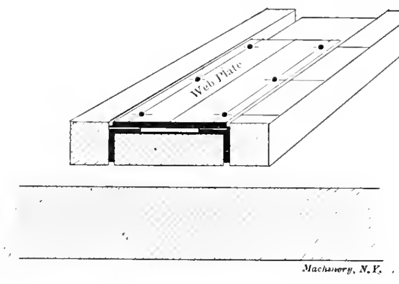


Fig. 5. Building Up a Channel Section.

and held temporarily in position with small brads, spaced about 6 inches apart down the center of the plate. (See Fig. 5.) The rivet and pin centers were then scratched across the plate, after which the same was taken up, and center punched. The plate was then put back in place and holes drilled through the L's and plate at the same time, after which they were taken from the form and riveted together. Eight of these sections were thus made, after which they were formed into posts in the following manner: a strip of wood of proper width and thickness was screwed to the bench on which were marked off the pin centers, and the location of the tie plates.

Two channel sections were then clamped in position, one on each side of the strip of wood, as shown in Fig. 6. The tie plates which had previously been made and tinned on their edges, were laid in position, and soldered fast with a blow-pipe. The lattice bars were then put on in a similar manner, one side of the post being completed at a time. The screws were then removed from the form and the lattice bars and plates of the opposite side were then soldered in place, after which the wood center was drawn out, leaving the completed post straight and true. The lattice bars were made of tin varying in width from 3/32 to 3/16 inch. They were sheared from sheets by hand. The lattice work was made on a form, and soldered together in full panel lengths. (See Fig. 7)

The I-section bracing was made in similar manner to the channel portion of the post, with the exception that rivets were only used at the ends to secure the L's to the connection plates. The L's were all tinned on one edge. The bottom ones were forced into slots on top of which was laid the lattice work, and at each end a tie-plate. The top L's were then laid on as shown in Fig. 8 and held in position from point to point by a steel pencil, while the pieces were soldered together. Having bored the holes in the end, through the plates and L's, the piece was removed from the form and riveted.

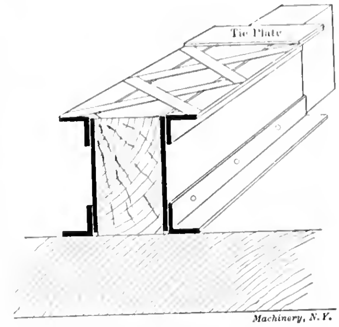


Fig. 6. Assembling a Latticed Column.

The bottom chord which is about 6 feet long was made in one piece. It is a box section, and of the same construction as the main posts already described. The only particular

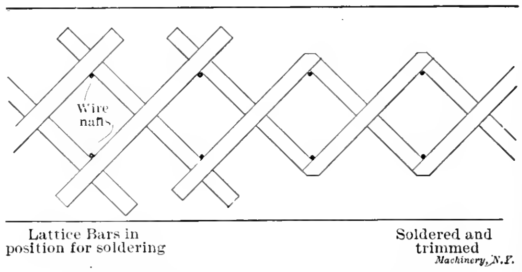


Fig. 7. Method of Soldering the Lattice Bars.

difference being in the latticing which is of small channels 3/16 inch in width, instead of flat bars. This latticing was not made in long strips, as was the latticing for the other members. Each X was made separately, being composed of three pieces of channel, a long piece and two short pieces with a small splice-plate to join the two short pieces together where they intersected at the center. They were soldered together on a form similar to that used for flat latticing.

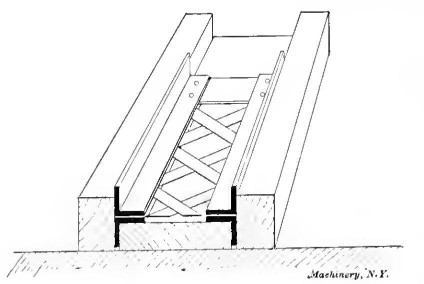


Fig. 8. Assembling the Latticed I-sections.

The sides of the chords have four lines of rivets along them, there being about 900 rivets in each, or 1,800 rivets in all, in the two chords.

The most difficult piece to make in the whole bridge was the box strut or brace on the lever arm end of the model. This strut was latticed on two sides with small L's, which came together at their intersections, and at the ends on small plates, the other two sides being latticed with flats. The strut is actually about 12 inches long, and is composed of 142 individual pieces. The two sides having the angle lattice

were made first. They were then clamped to a wooden center, in the same manner as were the web members, and the flat latticing was then soldered on. Great care had to be exercised in the soldering of this and other similar pieces, as the least excess above the amount of the heat required to make the solder run would have caused the whole strut to drop apart. The four finials on top of the main posts also gave considerable trouble on account of the great number of small parts, each containing 124 individual pieces. All curved. L's such as those on the small struts between the main tower posts were bent to an iron template to insure uniformity.

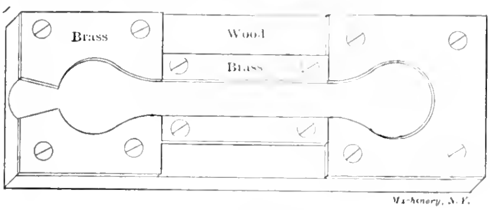


Fig. 9. Eye Bar Mold.

The floor beams and stringers were made in a similar manner to the I-sections, two angles being held in position by wooden strips, on top of which were placed a web-plate and the other two angles. They were then soldered together, after which holes were drilled through the angles and plates and riveted. These stringers and floor beams having been completed, the stringers were braced together in pairs with cross frames and laterals, and then riveted to the floor beams. They in turn were tap screwed to the vertical web members of the trusses. Tap screws were used, as it was necessary to take the model apart for shipment.

then substituted for the brass ones, as shown in Fig. 9, with better results, and finally after several successive attempts, the mold having become thoroughly heated, a full bar was cast, after which no further trouble was experienced. The bars were all drilled from an iron template to insure accurate length, center to center of pin holes.

The pins which hold the model together are made of steel, and vary in diameter from 9/32 inch to 15/32 inch, and in length from 1½ inch to 3 inches.

The pier is made of wood and is hollow. The stones instead of being carved on the surface, were made of blocks of thin wood and bradded on, the whole then being painted and sanded.

It required 42 of the original shop drawings of the bridge to construct this model. Throughout the work, no attempt was made to fit one finished piece with another; the drawings for each piece being accurately followed, and when the whole was completed, no difficulty was experienced in putting it together. The model is complete in every detail, as far as the structural work is concerned, except in the thickness of material and the number of rivets.

In order that the reader may get an idea of the enormous amount of work on a model of this kind, it may be stated that there were used, 698 lineal feet of drawn shapes, 200 lineal feet of web plates, 4,500 lattice bars, and 7,200 rivets. There were over and above 8,800 individual pieces. It was estimated that for the soldering of lattice bars alone there were over 14,000 little pieces of solder used. These had to be handled individually. It took about 1,000 hours to complete this work; the cost of material was about $50.

The locomotive shown in Figs. 1 and 2 is constructed of paper and wood and gives an idea of the comparative size of the bridge.

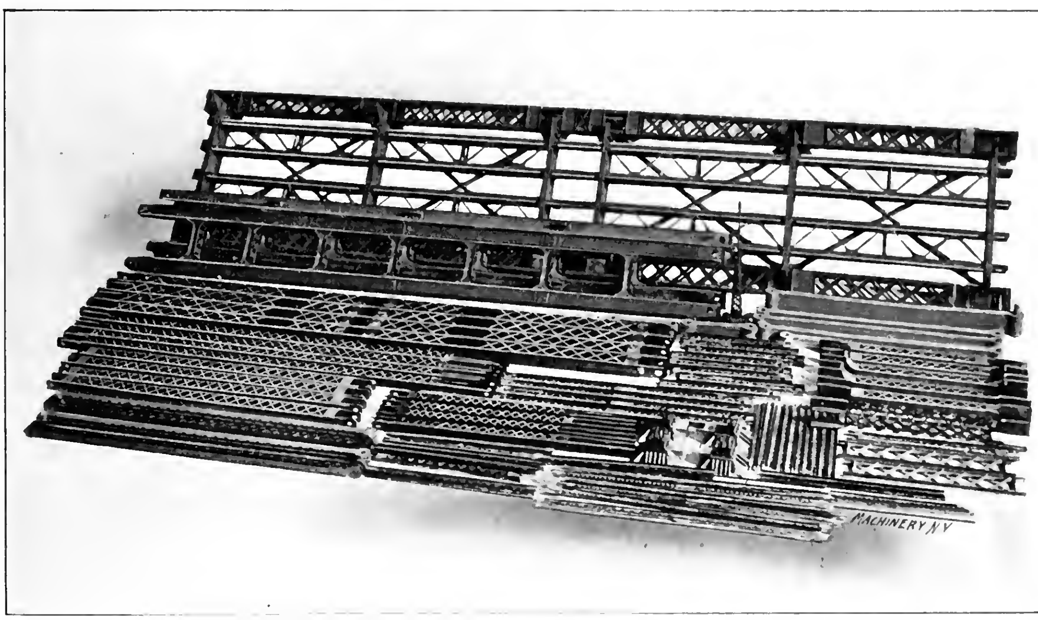


Fig. 10. The Completed Members, ready for Assembling.

In the upper chord there are five panels of I-bars, 28 bars to the panel and of four different lengths. To have cut these out by hand would have been a difficult task, and as the making of dies with which to stamp them would have been too expensive, it was decided to try to cast them of type-metal. The largest bar was 18 inches long, 7/16 inch wide, 1/16 inch thick. On account of the thinness of the bars it was doubtful if it would be possible to cast a bar so thin and of such length. The first attempt was made with a brass mold, but the metal refused to flow down further than one-third the length of the mold. The heating of the mold was then suggested, but on account of the time that would be lost in allowing the same to cool, it was thought best to try some other means for overcoming the trouble. Wooden sides were

[As an example of modelmaking this bridge model ranks high, having been built from the working drawings with scrupulous regard for accuracy of detail; the most important omission is the substitution of solder for rivets in the lattice work. The constructor is a structural engineer, with the firm who designed the bridge, and when it is known that he built the model nights and holidays in his home workshop with a few hand tools, its accomplishment naturally claims more attention from amateurs and others who sometimes indulge in model work than would be bestowed on it if done in a regular shop having a good tool equipment. Aside from this the methods of getting the required sections and assembling them so as to get the members straight and without wind are well worth the attention of any mechanic.—EDITOR.]

THE STRENGTH AND DUCTILITY OF STEEL.

F. E. CARDULLO.

The two most important characteristics of a steel, or indeed of any material with which the designer has to do, are its strength and its ductility. He is, in general, more interested in these qualities in steel than in any of the other of his materials, for steel having both of them in unusual degree, is naturally used in all constructions where their presence is of unusual importance. These qualities, fundamental, yet ever variable, depend on two things: first the kind and proportion of the substances present in the steel, and second the treatment of the steel during the process of manufacture.

It has often seemed curious to the writer that so little is known of the effects of the elements commonly present in steel. We know in a general way that carbon will make a steel hard, phosphorus brittle, manganese tough, and so on through the list. However no two authorities agree on the desirability of various proportions of the elements, and many are not even agreed as to whether or no some of the elements are injurious. It was with the idea of reconciling some of this warring testimony that the writer was moved some months ago to undertake to find out, if possible, HOW strong, and HOW tough the various elements present made the steel.

The elements commonly present in steel, besides the iron that forms the base of the metal, are carbon, manganese, silicon, sulphur and phosphorus. Besides these, many or all of which are present in every steel, special steels contain nickel, chromium and tungsten. The three latter elements confer valuable properties of hardness, toughness and temper on steels. Many other elements are sometimes found in steels, but after as much of an investigation as the limited data on the subject will allow, the writer is compelled to state that so far as he can discover, there are no elements other than these, that have an appreciable effect upon the strength or ductility of a steel.

It may be well at this point to understand in a broad and general way the method of manufacture of steel. There are at present in commercial use three kinds of steel, made by three different processes, known as the Bessemer, the open-hearth and the crucible processes. The first produces the cheaper grades of steel, used for rails and structural work, the second a better grade of steel, used for boiler plate, bridge work and heavy forgings, and the third a very fine quality of steel, used for tools, small forgings and high-class machine work. In general the process is the same in each case, namely, to purify and refine cast iron, to add to this refined product such elements as are necessary to give the required strength and temper, to cast the resulting mass into an ingot, and then to shape and refine that ingot by forging or rolling. There results a product whose strength we will measure in pounds per square inch, and whose ductility we will express by stating the percentage a piece originally eight inches long, will stretch before rupture.

Among chemists the amount of the various elements present is expressed in "points"; that is, in hundredths of one per cent of the whole mass by weight. Thus a steel having thirty points of carbon has in every pound of its mass .0030 pounds of carbon. The same quantity is more often expressed as .30 per cent, or as we say, thirty hundredths per cent. We are not compelled to estimate the amount of the substances present in this way, and indeed when special accuracy is sought, we often express the quantity of a substance present in thousandths of one per cent. We might have then a steel containing three and a half points of sulphur, or .035 per cent sulphur, or thirty-five thousandths per cent of sulphur, the three expressions being identical in meaning.

Without going into the very tedious details of finding the equations, the writer begs leave to present the two expressions in this article as representing the strength and ductility of a steel in terms of its chemical composition. Since the proof of the pudding is in the eating, we will then take up the analysis of several commercial steels, and compare their calculated strengths and ductilities with those shown by actual test. The formula for the strength of a steel has the form—

$$\text{Strength} = 36{,}000 + 630\,C + 500\,S + [1{,}000 - 5\,(Mn + C)]\,Mn + 1{,}000\,\sqrt{C} \times P$$

Where the strength is obtained in pounds per square inch,

C = the number of points of carbon present in the steel,

S = the number of points of sulphur present,

Mn = the number of points of manganese present,

P = the number of points of phosphorus present.

On looking this equation over we can come immediately to a conclusion as to the effect of the various impurities present on the strength of a steel. We see that a perfectly pure iron, if it could be obtained, would have a strength of 36,000 pounds per square inch, and that any of the impurities noted in the equation, when present in the proportions in which they are found in ordinary steel, add to the strength of the steel. Some add more than others, and they all depend more or less on each other for their effect. Thus, the more carbon there is present the greater the effect of the phosphorus. The more carbon and manganese together the less the effect of the manganese. For instance, in a steel containing only ten points of manganese, and no carbon, each point of manganese adds 950 pounds to the strength. If there were one hundred points of manganese, instead of ten, each one would add but 500 pounds, and if there were one hundred points of carbon also, the manganese would add nothing to the strength of the steel.

Authorities differ as to the effects of the different elements. For instance, some tell us that the sulphur weakens the steel, instead of strengthening it. Others will give different relations between the effects of the other elements present. I can only say first that the relations given agree substantially with the best authorities, and second, that they agree even more substantially with the observed facts in the case.

The formula for the ductility of a steel has the form

$$\text{Ductility} = 39.00 - 0.12\,Mn - 0.18\,(C + P) - 0.4\,S - \sqrt{Si} - 0.1\,(P \times \sqrt{C})$$

Where the ductility is obtained in per cent elongation before rupture,

Si = the number of points of silicon present in the steel,

C, Mn, S and P are the same quantities as before.

On inspecting this second equation, we see that all of the elements which add to the strength of the steel, also add to its brittleness, or what amounts to the same thing, take away from its ductility. We see that the effect of the phosphorus depends on the amount of the carbon present, in somewhat the same way that it did before. We see also that the element silicon detracts considerably from the ductility of the steel, without adding anything to its strength, and we may therefore conclude that it is a very mischievous element to have present. Carbon and manganese add most to the strength in proportion to what they detract from the ductility, and are therefore the most desirable elements to have present in the steel.

It is, however, neither desirable nor possible to have a steel free from all elements but these. The other elements are present as impurities in the iron ore and the fuel, which are used at every stage of the process of steel making, and while it is generally possible to reduce them to a very small amount, it is impossible to eliminate them entirely. Then, too, the presence of some of these impurities is absolutely necessary in order that the steel shall be sound and readily worked. The element silicon in particular has a highly beneficial effect, in making the steel more sound and homogeneous. Steel having a very small percentage of impurities has two faults. In the first place, when the liquid mass is cast into an ingot, what impurities there are will have a tendency to gather into one place, thus forming spots too hard and brittle, in a steel otherwise too soft and weak. This trouble is termed segregation, and is obviated by a sufficient proportion of impurities, the most efficient in overcoming it being silicon. The second fault is the presence of gas in the cooling mass in the form of bubbles. These bubbles form vacant spaces in the ingot, and when they are flattened out in working, they become flaws in the finished piece. The remedy is again a larger proportion of impurities, and again the most useful is silicon. So that an element that adds nothing to the strength and takes away

not a little from the toughness of a steel, is nevertheless one of its most valuable components.

Although these equations give a very close approximation to the strength and ductility of most steels, there is no reason why any steel should not depart widely, in its properties, from those indicated. It will be found that the steel may be stronger or weaker than the equations would indicate, but never of a very much greater ductility, except where there is a large proportion of nickel present. The reason for this is that the strength of a steel depends on the manner of working it as well as on its chemical composition. For instance, if it is not thoroughly worked, it will be soft, weak, and not very tough. The more thoroughly it is worked, the stronger and tougher it will become. A plate two inches thick will not by any means be as strong and tough as a plate one-fourth of an inch thick, for the reason that the thinner plate is much more thoroughly worked. These equations apply to plate of three-eighths inch thickness, or equivalent section in other forms than plate, and an appropriate correction must be made when the thickness differs materially from that value. This correction will be about one per cent reduction in strength and ductility for each eighth of an inch above three-eighths inch thickness.

Excessive working, on the other hand, adds very much to the strength of a steel, but is at the expense of its ductility. For instance, the strength of a steel may be about doubled by wire drawing, but the ductility will then become a very small fraction of one per cent. In the case of a steel containing a large proportion of carbon, the manner of cooling after working will have a very important effect. Sudden cooling or hardening, as we commonly call it, has the same effect as cold working. The amount of the effect will depend on the proportion of carbon present, the temperature from which it was cooled, the temperature to which it is cooled, and the length of time in which the cooling takes place.

Thus we see that the strength of the same piece of steel may vary from time to time, according to the kind of treatment which it last received, and the ductility may vary in a similar manner. The treatment assumed is that the steel was thoroughly worked at the proper heat, and was then allowed to cool slowly in the open air. This is the condition in which we find steel ordinarily on the market. Even with the same composition, and when treated in the same way, two pieces of steel will differ considerably in their physical properties. In a series of fourteen tests made upon bars of the same section, and rolled from the same heat, the strengths of the different specimens varied by as much as four per cent, and the ductilities by nearly ten per cent. The equations are intended to apply to the average, and not the extreme cases.

The formulas are thus an indication of the previous treatment of the steel. If the steel is stronger and less ductile than the chemical analysis would indicate, it is because the metal has been worked at too low a temperature, or else has been hardened. If it is too weak and brittle, it has not been sufficiently worked. In general, the closer the strength of the metal agrees with its calculated strength, the greater will be its ductility. The formulas thus point out to us where the mistakes have been made, and how they may be rectified. Not only this, but they enable us to calculate the composition which will meet given specifications, determining the maximum allowable quantity of impurities, and thus tell us what ores and processes we may use to get given results.

As an example of the use of the formulas, we will take first the case of a steel intended for rifle barrels, and reported by Thurston. This steel had the following composition: Carbon, .325 per cent; manganese, .677 per cent; sulphur, .057 per cent; phosphorus, .020 per cent; silicon, .047 per cent. The actual tested strength of this steel was 99,640 pounds, and its elongation 19.00 per cent. From our formulas we have:

Iron		36,000
630 C	630 × 32.5 ..	20,500
500 S	500 × 5.7....	2,850
[1,000 — 5 (Mn + C)] Mn.	[1,000—5 (67.7 + 32.5)] 67.7	33,800
1,000 $\sqrt{C}$ × P..........	1,000 $\sqrt{32.5}$ × 2	8,050
	Strength ..	101,200

Iron		39.00
0.12 Mn	0.12 × 67.7.....	8.12
0.18 (C + P)............	0.18 (32.5+2.0)	6.20
0.4 S	0.4 × 5.7	2.28
$\sqrt{Si}$	$\sqrt{4.7}$	2.16
0.1 (P × $\sqrt{C}$)..........	0.1 (2.0 × $\sqrt{32.5}$)	1.14
		19.90
	Ductility	19.10 per cent

This is an excellent metal, properly worked, and its only fault is a rather large amount of sulphur.

A series of tests was made by government experts between 1875 and 1878, to determine as far as possible the relation between the strength and composition of steels. From the instances reported of their work by Thurston in his "Materials of Engineering" I have selected at random five steels. Their chemical analysis, their calculated strengths and ductilities, and the value of the strengths and ductilities found by actual test, are given in the following table:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Carbon	.009	.049	.460	.908	1.142
Sulphur	.009	.007	.002	.002	none
Phosphorus	.084	.179	.020	.014	.020
Silicon	.163	.219	.121	.141	.204
Manganese	.020	.063	none	.036	.282
Calculated strength ...	41,700	54,900	74,400	106,200	130,500
Actual strength	43,000	55,000	71,000	118,900	130,400
Calculated ductility ..	31.88	25.25	25.50	16.08	9.15
Actual ductility	29.67	25.50	20.17	11.08	8.67

Taking the steels in their order, we see that the first was cold worked, in order to raise its strength. If this metal had four points of carbon additional, in place of four points of phosphorus, it would be very much improved in strength and ductility. The second steel is properly worked, but it has entirely too much phosphorus. The third is of excellent composition, but it was not sufficiently worked. The fourth was worked at too low a temperature, or more probably was allowed to cool too fast. The fifth was perfectly treated, and its only fault is a little more silicon than is necessary.

* * *

In the construction of a certain magnetic clutch it was desired to interpose a thin brass disk between the magnetic member and its keeper, or mating disk, to overcome the effects of residual magnetism. The attempt to make the thin brass disk an attachment to one of the cast-iron plates was a failure; the rivets were quickly torn out of the brass disk and the latter ruined. Then the expedient of using the brass disk without securing it to either of the clutch disks was tried with complete success. The wear on the brass plate was found to be very slight, and it filled its function satisfactorily in every respect. This experience has been paralleled many times. Another example of quite different character might be mentioned and that is the false valve seats frequently used on locomotive cylinders. It is usual to make the valve seat for slide valves so as to give an inch or more wearing surface. When the metal has worn away and the remainder of the cylinder is still in good shape it is customary to put on a false valve seat which is a piece shaped like the original seat, but only 1¼ or 1½ inch thick. It was formerly the practice to secure this seat to the cylinder by screws or dowels. These quickly worked loose with the usual result of ruining the valve and sometimes the cylinder. It was finally proposed that no attempt be made to hold the seat to the cylinder, but to provide it with lugs fitting inside of the steam chest, so as to hold it in position and to let the steam pressure take care of holding it down firmly enough to prevent leakage. The plan was entirely successful and is now the most common practice wherever false seats are used.

* * *

The largest gasholder in the country and possibly in the world is said to be that under construction at the Astoria works of the Consolidated Gas Co. of New York. It is 300 feet in diameter and will rise to a height of 260 feet when fully inflated. Its capacity will be 15,000,000 cubic feet.

DESIGN OF THE WESTON LOAD BRAKE.

ULRICH PETERS.

To safely hoist, hold and lower a load, hoisting machinery is usually equipped with so-called safety, automatic, or retaining brakes. These brakes permit a load to be lifted freely by the motor and lock the brake by the gravity action of the load as soon as the lifting torque of the motor ceases to act in the hoisting direction. The load is retained by the brake in any position and it is only when the motor runs in the lowering direction that the acting power of the brake is diminished, allowing the load to descend. The speed at which the load drops is regulated and determined by the lowering speed of the motor, while the brake, in the meantime, absorbs by friction the greater part of the potential energy of the dropping load, and generates heat in the brake.

As an example for calculation, the writer has selected one of the best mechanically designed brakes, which is shown in the sectional views. The ratchet is free to revolve when hoisting, but is held by two silent pawls from turning in the lowering direction. The friction nut is geared to the motor and the retaining shaft with gear pinion leads to the hoisting drum. The retaining shaft and friction nut are threaded either right- or left-hand, according to the hoisting direction. The friction flange is keyed to the retaining shaft and mates with the friction nut by means of three jaws which have about 15 degrees angular play. The friction flange drives the pinion direct through tongued and grooved projections between the pinion and flange. Any tendency of the load to revolve the retaining shaft when the motor is at rest, causes the friction flange with friction disk to be pressed against the ratchet wheel and the thrust washer of the nut, due to the screwing action of the threads. The friction of this washer against the ratchet wheel, which, as already explained, does not turn in the lowering direction, is sufficient to hold the load. Upon starting the motor to lower, it turns the friction nut and relieves a certain amount of pressure on the washers, until the pressure is overcome so far as to permit the load to revolve the friction flange in unison with the speed of friction nut, or motor. The heat generated in the brake is therefore an easily determined quantity and in direct proportion to load and lift, and on this account sufficient radiating surface must be allowed in the brake, so as not to burn the oil. In hoisting, the jaws of the friction nut and flange engage, thus relieving the brake of all friction.

The moment of friction, in inch-pounds, of a washer between two plane disks, when the pressure is evenly distributed over the whole surface, is expressed by the formula

$$M = \frac{2}{3} f P \frac{R^3 - r^3}{R^2 - r^2},$$

Where P = axial force; f = coefficient of friction; R = outer radius of ring, and r = inner radius of ring.

Theoretically, as well as in practice, the outside of the friction disk wears away faster than the inside, with the result that the pressure becomes unevenly distributed, being greater at the inner and less at the outer edge, which latter part is worn away much faster, so that for the above formula we may write,

$$M = \tfrac{1}{2} f P (R + r) \qquad (1)$$

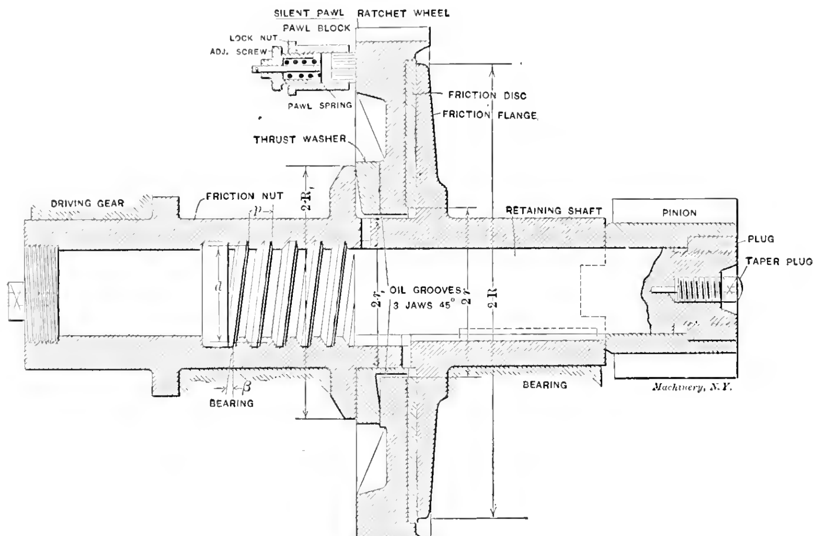
Same can also be said about the thrust washer, so that

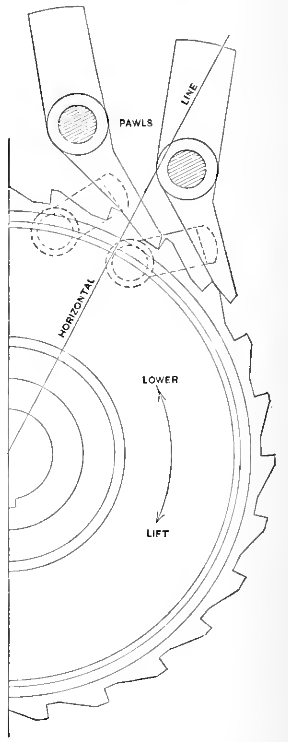
$$m = \tfrac{1}{2} f_1 P (R_1 + r_1)$$

Hence, the combined moment of friction is equal to

$$M + m \qquad (3)$$

As we have seen above, the friction work, which must be transformed into heat, is in turn radiated by the brake. It is evident that sufficient radiating surface must be allowed for





The Mechanism of the Weston Load Brake for Cranes and other Hoisting Machinery.

the washers, and average practice calls for about 0.0003 to 0.0005 square inch for each foot-pound destroyed per minute. Or, in other words, one square inch of washer surface is sufficient for 3,333 to 2,000 foot-pounds per minute. Letting the lifting capacity of the crane = T in tons, and the lowering speed = S in feet per minute, the required combined area of friction and thrust washer is from

$$A = 0.6\, S\, T \text{ to } A = S\, T \qquad (4)$$

in square inches.

After having determined the required area of washers, it is now up to the designer to place the brake on the proper speeded shaft, where the axial pressure due to the threads of the friction nut and retaining shaft can be made to give the least wear. The best results have been obtained in practice at about 100 revolutions per minute of retaining shaft at the maximum lowering speed.

The following equations apply to angular thread screws for figuring the axial pressure P when the torque or turning moment L of load is acting on the retaining shaft. f_2 = coefficient of friction of screw and nut; other dimensions are shown in cut.

$$P = L \frac{2\,(\pi\, d - p\, f_2 \cos\beta)}{d\,(p + \pi\, d\, f_2 \sec\beta)}$$

In the above equation we see that the axial pressure is in direct proportion to the torque L. This torque must be taken

up by the friction moments m and M of washers, as given in the formulas 1 and 2. By substitution we obtain

$$f(R + r) + f_1(R_1 + r_1) > \text{or} = d\,\frac{(p + \pi\, d\, f_2 \sec\beta)}{(\pi\, d - p\, f_2 \cos\beta)}$$

from which formula the proportion of the pitch p and other parts, as angle β, middle screw diameter of screw, etc., can be checked against the radii R, r, R_1 and r_1, when the friction of washer, thrust washer and screw are obtained from reference tables for the different materials.

* * *

REDUCING GUN RECOIL.

The reaction or kick of a gun is not measured entirely by the momentum imparted to the projectile by the burning powder, but a considerable portion is caused by the acceleration of the burning gases themselves. For example, the free recoil of a .50-caliber rifle weighing about 8½ pounds and firing a cartridge containing 100 grains of black powder and 450 grains of lead, is about 25 foot-pounds, as actually demonstrated by experiment. The muzzle velocity of the bullet is about 1,400 feet per second. Now, since the momentum of the gun and the momentum of the bullet are equal, $W \times v = w \times V$, in which W = the weight of the gun; V = velocity of the bullet; w = weight of the bullet; v = velocity of the recoil of the gun. Substituting the known qualities in the example in question we have $8\frac{1}{2} \times v = \frac{9}{140} \times 1{,}400$ or $v = 10.6$ feet per second, velocity of recoil. By the formula $E = \frac{W v^2}{2g}$ it is calculated that $E = 15$ foot-pounds, nearly, = recoil of the gun, but the actually measured recoil as previously stated is 25 foot-pounds, the excess of 10 foot-pounds respresenting the recoil due to the 100 grains of powder, the gases of which escape from the gun with a much higher velocity than the bullet the moment the latter has left the muzzle. The fact that smokeless powders develop a much greater energy for the same weight than black powder explains why they give less recoil with the same or even higher projectile velocities. The reaction due to the expanding powder gases has been utilized in the McLean invention to reduce the recoil. The scheme is simply to divert the gases backward by a deflector as they leave the muzzle. In small arms, holes are drilled diagonally in the muzzle of the gun so that the gases shoot backward, and thus instead of adding to the reaction caused by the bullet a considerable reduction is effected, it is claimed. Suppose in the case in question where the reaction was 25 foot-pounds, 10 of which is due to the reaction of the weight of the burning powder itself, that all the powder gases could be reflected directly backward; then instead of having a reaction of 25 foot-pounds it would only be 5 foot-pounds, inasmuch as 10 foot-pounds would be subtracted from 15 foot-pounds, instead of being added to it.

* * *

An interesting form of piston packing was recently described in *Engineering*, which is made at the Craigton Engineering Works, Craigton, Glasgow; it is designed for use in steam engines, gas engines, pumps, air compressors, etc. It consists of three rings, the two outer rings being the packing rings proper, while the center ring is a tension ring. This ring has about double the amount of spring power possessed by the other two rings, and its construction is such that it does not touch the cylinder walls, its pressure being transmitted to the two side rings instead. The angle made by its side is such that the resultant side pressure tends to lock the bearing rings in the groove and thus produce a semi-solid piston. Hence it does not have the defect common to steam set packing rings of wearing the cylinder bore large at the ends when the steam pressure is greatest. The packing is made of a special cast-iron mixture for steam, etc., but when used for water pumps the rings are made of a special bronze. The packing is particularly recommended for superheated steam with high piston speeds, and it is claimed that it does away with the chattering that takes place with some other forms of rings. The construction is simple, being straight lathe work, with no hand fitting whatever required.

HORSE POWER TRANSMITTED BY BELTS.

F. WACKERMANN

Engineers' textbooks give much and varied data for calculating the number of horse power that may be transmitted by belts; nevertheless, the following rules and tables used by the transmission department of the Jones & Laughlin Steel Co. may be of interest.

The centrifugal tension due to a strip of belt one inch square and one foot long, moving at a velocity of V feet per second = $0.012\,V^2$, weight of belt (leather) taken at 56 pounds per cubic foot.

Working tension of belt = T.

t = thickness of belt in inches.

Effective tension of belt = $T - 0.012\,tV^2$.

$$\text{H. P.} = \frac{(T - 0.012\,tV^2)\,V}{500}$$

T is taken as follows:

45 lbs. per inch of width for single belts 3-16 inch thick.
80 " " " " " " double " 3/8 " "
110 " " " " " " triple " 9-16 " "
145 " " " " " " 4-ply " 3/4 " "

From the above data the following table has been calculated:

H. P. = 0 when $T = 0.012tV^2$ or at the following speeds:

8,485 feet per minute for single belts.
8,000 " " " " double "
7,659 " " " " triple "
7,616 " " " " 4-ply "

This table shows that there is no advantage in speeding belts up to more than 4,400 to 4,800 feet per minute and demonstrates the folly of using excessively high speeds. The number of horse power given can only be increased by sacrificing the life of the belt.

TABLE GIVING THE NUMBER OF HORSE POWER TRANSMITTED BY BELTS ONE INCH WIDE, CONSIDERING THE EFFECTS OF CENTRIFUGAL FORCE, SO THAT THE TENSION ON BELT IS CONSTANT AT ALL SPEEDS.

Speed in Feet per Minute.	Thickness of Belt.				Speed in Feet per minute.	Thickness of Belt.			
	Single.	Double.	Triple.	Four-ply.		Single.	Double.	Triple.	Four-ply.
100	.14	.24	.33	.44	3400	3.89	6.74	9.10	11.96
200	.27	.48	.67	.88	3600	4.03	6.95	9.35	12.28
300	.41	.73	1.00	1.32	3800	4.14	7.12	9.55	12.57
400	.54	.96	1.33	1.75	4000	4.24	7.26	9.70	12.73
500	.68	1.21	1.66	2.19	4200	4.33	7.36	9.79	12.84
600	.81	1.44	1.99	2.62	4400	4.39	7.42	9.83	12.88
700	.95	1.68	2.31	3.05	4600	4.43	7.44	9.80	12.84
800	1.08	1.93	2.64	3.48	4800	4.45	7.42	9.72	12.71
900	1.21	2.15	2.96	3.90	5000	4.45	7.37	9.56	12.50
1000	1.34	2.38	3.28	4.32	5200	4.43	7.26	9.34	12.20
1100	1.47	2.61	3.59	4.73	5400	4.38	7.10	9.05	11.80
1200	1.60	2.85	3.90	5.14	5600	4.31	6.92	8.69	11.30
1300	1.73	3.07	4.21	5.55	5800	4.21	6.65	8.25	10.70
1400	1.86	3.30	4.51	5.94	6000	4.09	6.35	7.73	10.00
1500	1.98	3.53	4.81	6.31	6200	3.94	6.01	7.13	9.19
1600	2.10	3.73	5.10	6.72	6400	3.76	5.58	6.44	8.26
1700	2.23	3.94	5.39	7.10	6600	3.56	5.11	5.67	7.22
1800	2.34	4.15	5.67	7.47	6800	3.32	4.57	4.80	6.06
1900	2.46	4.35	5.94	7.83	7000	3.05	3.98	3.84	4.77
2000	2.58	4.56	6.21	8.18	7200	2.75	3.31	2.79	3.36
2200	2.80	4.94	6.73	8.85	7400	2.42	2.60	1.64	1.82
2400	3.01	5.30	7.21	9.51	7600	2.05	1.82	0.39	0.14
2600	3.21	5.65	7.67	10.09	7800	1.65	0.95	...	.....
2800	3.40	5.97	8.09	10.64	8000	1.21	......	......	......
3000	3.58	6.25	8.47	11.14	8200	0.74	......	......	......
3200	3.74	6.52	8.80	11.58	8400	0.23	......	......	......

In all the above data it is assumed that the arc of contact of the belt is not less than 180 degrees.

If this arc is........	90°	112½°	120°	135°	150°	157½°	180°
Divide H.P. given by	2.21	1.72	1.6	1.4	1.21	1.17	1.

* * *

As regards the efficiency of gasoline for power generation when consumed in an internal combustion engine, or when burned under a boiler to generate steam, it is found to be about as 2 to 1 in favor of the internal combustion type.

NEW SHOPS OF THE WESTERN ELECTRIC CO.

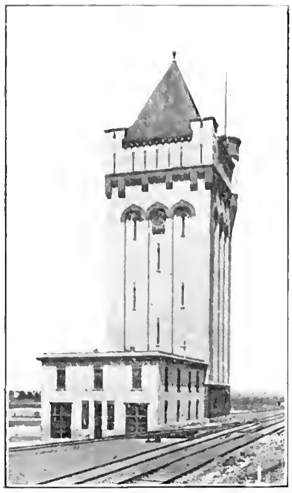


Fig. 1. Water Tower.

The new Hawthorne (Ill.) shops of the Western Electric Co. comprise a group of model buildings for the manufacture of direct and alternating current motors and generators, and of rubber in the various forms required for electrical work. The design, appointments and equipment of the plant are all that experience and an extended study of the existing conditions could dictate, and the result is a manufactory complete in every detail, with its own sources of supply for heat, power, light, water, gas, etc.

In Fig. 2 is the foundry, which is a brick and steel structure, having a Luci Viti tile roof. The building is 400 feet long, divided into three bays. Over the center, or main bay, which is for large work, are located two thirty-ton cranes. The West bay is 75 feet wide and has a low roof; it being used exclusively for bench work. The East bay which is 30 feet wide, is divided into sections containing the cupolas, storage bins and core ovens.

The machine shop, lying at right angles to the foundry, is 860 feet long and 150 feet wide, and is of the same type of construction, except the roof, which is of steel and tarred roof construction. There are three bays; the center one, 76 feet wide, is devoted to the manufacture of generators and motors. The north bay, 48 feet wide, contains such machine tools as are required in the manufacture of small types of machines. In this bay is located the testing department. The south bay has two floors; the upper one being devoted to the manufacture of small field coils and the winding of small armatures. It also contains the small detail and finishing departments. The lower floor contains the commutator and large detail departments, stock rooms and general shop offices, including that of the shipping department. The lighting is obtained from overhead skylights and side windows. Over the main bay are located two 30-ton, and over the north bay six 20-ton cranes. The entire plant is equipped with a system of industrial railways.

On the opposite side of the track from the shop and foundry is the cable plant, which covers a very large area and is now being increased to still further extent. The buildings of this department are of one story, with saw-tooth roof.

The power plant comprises an engine and boiler room, with space for two batteries of eight boilers, each. One battery of Aultman and Taylor boilers has been installed, with chain grate stokers and Greene fuel economizers.

The main railroad tracks dividing the company's property afford an easy means of handling the coal as they are of such a height that cars may be switched by means of an elevated spur track into the storage bins located above the boiler room. These bins are of 1,000 tons capacity and are so designed that the coal may be discharged through spouts into a hopper scale for each division of boilers. This scale is mounted on a track, so as to take the coal from any part of the bin and deliver it to any one of the stokers. The ash is discharged at the end of a chain grate stoker into a bin of 1½ ton capacity located below each boiler. From these bins the ash may be delivered into gondola cars and taken by means of a depressed railroad track to various places about the plant where filling may be required.

Fig. 2. Foundry of the Western Electric Co.

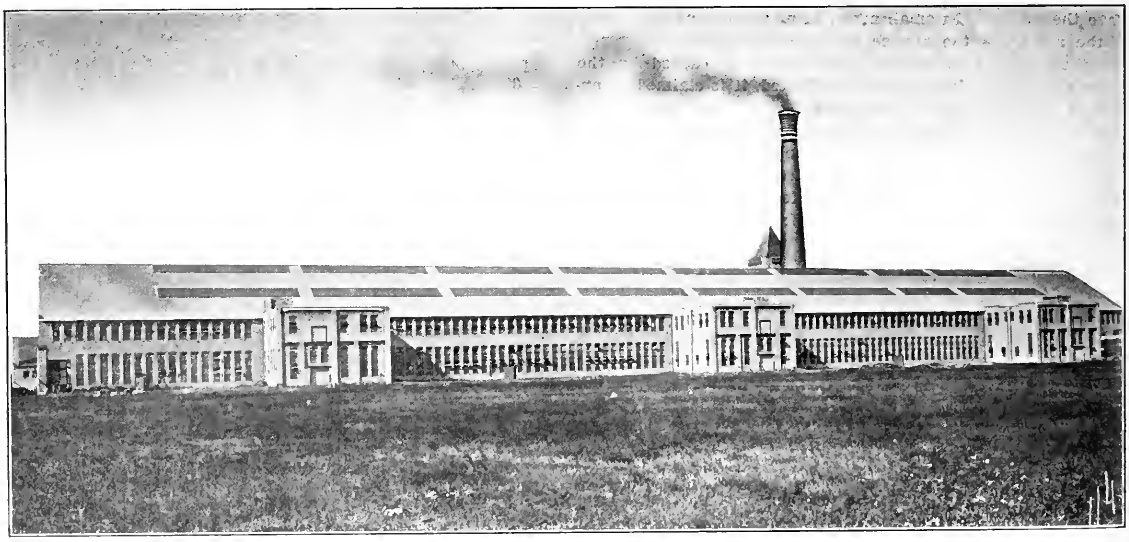


Fig. 3. General View of Machine Shop.

The continued uncertainty of the coal supply, due to strikes and other conditions beyond the control of the manufacturer, has led to a careful consideration of the problem of coal storage. The Western Electric Co., after investigating the question, decided to follow the practice adopted by the British Admiralty. Two storage bins, one of 4,000 and the other of 10,000 tons capacity, both located below the normal ground level, have been constructed into which coal may be dumped from cars and taken out by means of a locomotive crane fitted

with a grab bucket. Carefully executed tests in Europe show that nearly 30 per cent of the heating value of coal is lost in six weeks when stored exposed to the air. By keeping the bins flooded, the company expects to reduce the losses of the coal to approximately two per cent of its heating value after six months to a year storage. By this system of storage there is provided sufficient coal to operate the plant under normal winter conditions for four months.

The engine room has four units of 300, 500, 1,000 and 1,200 K. W. capacities. The largest generator is driven by a vertical compound Rice and Sargent engine; the 1,000 K. W. generator by a vertical compound Filer and Stowell engine; and the two smaller generators by horizontal cross-compound engines. Three Wheeler surface condensers are installed.

Water for the power plant comes from an adjacent reservoir. A water tower of artistic design has been built for supplying the hydrants and sprinklers, and the lavatories. The reservoir and water tanks receive their supply from the city systems. Drinking water is obtained from a well.

Compressed air is supplied to the whole plant from a compressor in the engine room, for pneumatic tools, for blowing out cables, operating molding machines, etc.

Uncarbureted water gas, used in the heating and baking ovens and annealing furnaces about the plant, is furnished by two generators, each with a capacity of 25,000 cubic feet per hour. The gas is stored in a tank of 100,000 cubic feet capacity, and has a heating value of approximately 300 B. T. U. It is made from a good grade of furnace coke, and costs, exclusive of fixed charges, such an amount as to compete favorably with 12,000 B. T. U. coal at $2.80 per ton. It has approximately 50 per cent of the heating value of, and costs 50 per cent less than city gas.

A second tank is being constructed which will enable the company to run one gas generator during the entire twenty-four hours with pronounced economy over present conditions, which require both generators to work at certain times of the day.

All buildings are heated by direct radiation except the foundry and machine shops, the foundry being equipped with a hot-air system, while the machine shop has a combined direct radiation and hot air system. The heating coils are supplied with steam under the Warren-Webster system. In the wintertime one or more engines are operated non-condensing, the steam circulating under slightly less than atmospheric pressure. The efficiency of this arrangement is apparent when it is considered that during last winter no steam was required for heating other than that furnished by the exhaust of the engine.

A feature of interest is a crematory for the shavings and chips from the carpenter shops. It contains a boiler and Dutch oven especially for the purpose. The electrical equipment of the plant comprises Western Electric apparatus and the tools are electrically driven throughout.

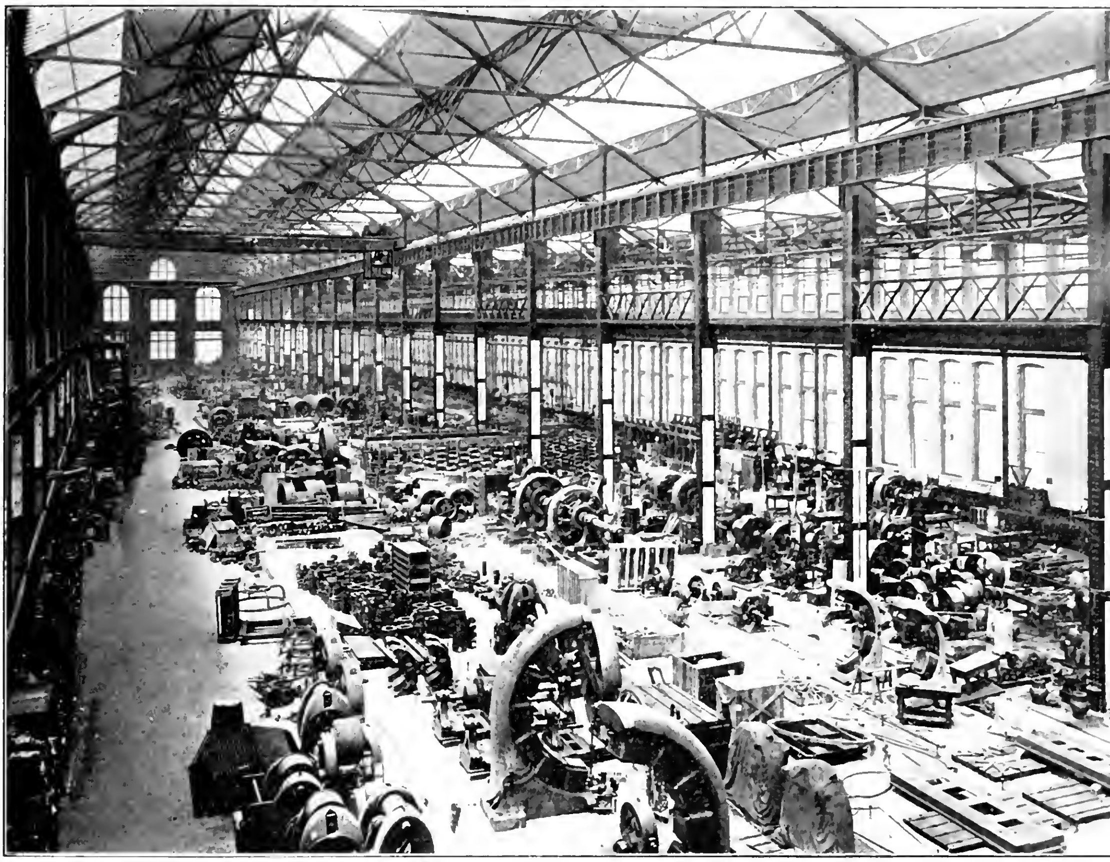


Fig. 4. Interior of Machine Shop.

The various buildings are connected with the power house by a system of well lighted and ventilated tunnels in which are located the telephone, lighting and power cables, and pipes for the drinking, city and house water, compressed air, live and exhaust steam, vacuum and trap returns, roof drain and hydraulic elevators. These tunnels have a uniform height of 7 feet, and vary in width from 4 to 10 feet.

Connecting with the tunnel leading to the Machine Shop, is a system of concrete trenches surrounding the iron plates of the testing floor. Within these trenches are cables leading into junction points at which are available for testing purposes all voltages from 30 to 600 volts, both direct current and alternating current of 25 and 60 cycles.

Careful attention has been given to the fire hazard. An engineer trained in the inspection of manufacturing properties, devotes his entire time to the fire protection devices and to the safeguarding of all of the processes of manufacture. In

general, the different departments have one-story buildings by themselves, each far enough removed from its neighbor to eliminate the danger of fire spreading. Large areas are divided by heavy fire walls with double tin-clad doors at the openings.

The walls are of brick, with wire-glass windows at exposed points, and the floors of concrete or concrete with wooden surface. The roofs are tile on structural steel. With the exception of three buildings, the property is protected throughout by automatic sprinklers. The three exceptions are the foundry, forge shop and main body of the machine shop, in which there is absolutely no combustible material.

An interesting feature is a circle of sprinkler pipes with heads on the sides of each steel post supporting the roof in the machine shop. These heads are about 15 feet above the floor and are designed to protect these posts from danger that may arise from inflammable material gathering about their bases. The sprinkler system is supplied with water through an elaborate yard system of about 13,000 feet of 10- and 12-inch water pipe, the feed into each building being controlled by a gate with a post indicator so that the supply may be regulated without entering the building, a valuable feature in time of fire.

Forty fire hydrants, each with three or four independent gates, are located about the property on the same yard mains that supply the sprinkler system and are so placed as to make possible the complete surrounding of any one building by fire streams. Each hydrant is protected by a wooden house in which are stored hose play pipes, axes, lanterns, etc. The amount of hose varies per hydrant from 200 to 500 feet, depending upon the length of the line that the particular hydrant is likely to be called upon to furnish. There is as well, 1,000 feet of hose on the carts in the fire station. This makes a total of about 6,000 feet of 2½-inch fire hose.

In the fire house adjoining the tower containing the sprinkler tanks are two 1,500 gallon Underwriters' fire pumps ready for instant duty. These pumps are each capable of throwing six good fire streams and draw their supply from the large reservoir, pumping into the yard system, thus supplying both the sprinklers and the hydrants as needed.

There is available in the tower for the sprinkler system and hydrants—213,000 gallons of water, and as soon as the pumps are placed in operation an additional supply of 3,000 gallons per minute so long as the 5,000,000 gallon reservoir holds out. Running both pumps full capacity the reservoir will last for 27 hours.

All of the buildings are liberally equipped with water and sand pails for fire use, with chemical extinguishers and with small hose connected to the sprinkler system. There is about 4,500 feet of this small hose distributed throughout the different buildings.

This elaborate and expensive system of fire protection would be of small value if trained men were not available for instant fire duty; therefore, the company maintains a fire brigade among its employees.

An ex-member of the Protective Department from the city of Chicago is the chief of the fire department, and devotes his time solely to the apparatus and the training of the brigade. Under him, during the day, are sixteen men employed in the department near the fire house who respond to all alarms. These men are picked for this special duty and are given extra compensation, including pay for drills as well as for fire service. At least twice a week a trial alarm is rung in, the department drilled with the use of the different apparatus, and familiarized with the surroundings and conditions that they would be likely to meet in time of fire. At night nine watchmen with a fire captain form a brigade, there being at least five of them at all hours of the night in the pump house where beds are provided for sleeping accommodations.

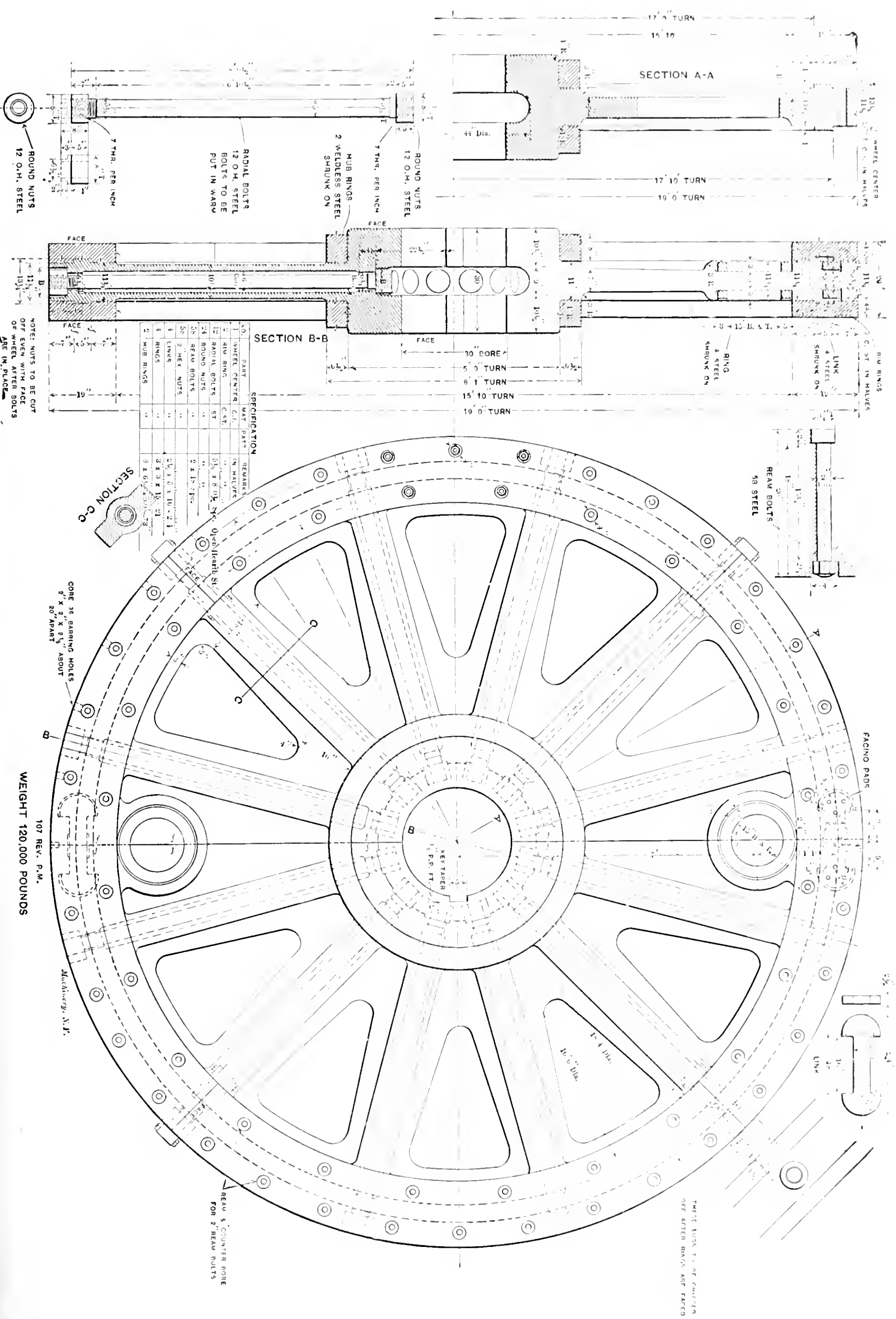
A system of forty-seven fire boxes has been installed, permitting prompt notification to the fire house, the members of the fire brigade, the engineer in charge of the fire pumps and the shop superintendent, so that immediately all of the trained force may be on duty. The average time taken to get sixteen men and two streams of water at any point of the property is less than two minutes after turning in the alarm.

SIXTY-TON FLYWHEEL.

A 19-foot flywheel of special and interesting construction, which was built about one year ago by the Nordberg Engineering Co., Milwaukee, Wis., for a mine pumping engine operated by the Calumet & Hecla Mining Co., is shown in detail in the full page cut herewith. The wheel weighs 120,000 pounds and is designed to run at 107 revolutions per minute which means a peripheral speed of nearly 6,400 feet per minute. A reasonable factor of safety for this speed requires a construction considerably stronger than possible with the usual plain form of cast iron flywheel. The nominal safe speed limit for cast iron wheels is put at about 5,000 feet per minute but the jump to 6,400 feet means that the bursting stress is increased in the ratio of 2.5 to 4.10. It might be argued that reversing rolling-mill flywheels which are subjected to tremendous shocks by reason of constant reversals are made of plain cast iron construction and stand up to the work with very few failures, but this argument would be made without taking into consideration the great increase of centrifugal force incident to increasing the speed even as little as 10 per cent. Between the reversing rolling-mill flywheel running at say 4,000 feet per minute and this wheel running at 6,400 feet per minute the centrifugal stress, which increases as the square of the velocity, as is evident in the formula for centrifugal force, $F = 0.000341\ W R N^2$, changes the factor of disruptive stress in the ratio of 1.6 to 4.10. The stress on the reversal does not directly affect the integrity of the rim, but does throw a heavy bending stress on the spokes, hence the part of a reversing flywheel which is most affected at reversing is the spokes and not the rim. Therefore, the comparison between the plain reversing mill flywheel and the reinforced wheel forming the subject of this description should be made on the basis of speed alone and not with reference to the effect of reversal.

The Calumet & Hecla wheel is made up of two cast iron segments forming the wheel center. These segments are held together by two steel shrink rings on the hub, four shrink rings under the rim and two steel rim rings made in halves and secured to the sides of the cast iron rim of the wheel center by 58 bolts 2 inches diameter and 18 inches long. In addition the halves of the wheel center are bound together by four T-head steel links set in the pockets underneath the rim rings and shrunk on in the usual manner. The spokes are cast hollow and 12 open-hearth steel bolts 5 inches diameter are set radially therein, being secured at the ends by round nuts fitting in countersunk seats. These bolts are warmed up before being put in place and the nuts are screwed up tightly before cooling, thus getting a heavy compression effect on the spokes due to the contraction of the bolts, the intention of the designer being to relieve the cast iron parts of all tensional strain due to centrifugal force. The spokes of the cast iron wheel center have an open space between each pair save at the junction of the halves where the web is made solid, having a thickness of 7 inches next the hub. A boss is cast on each side under the rim in which an annular seat is machined with a boring bar for four steel shrink rings which bind the two halves together. The rim rings are steel castings and are provided with temporary lugs for bolting together for the boring and facing operations in the boring mill. After being bolted to the sides of the cast iron center the lugs are chipped off, leaving a smooth surface.

The blueprint from which our cut was made was reproduced with little change and it will be noted that complete information regarding the construction of the wheel is given thereon. For this reason we would commend it as an excellent example of what a shop drawing should be. The drawing, notes and tabular specifications, together with the table of weights (which latter is not shown on the cut), gave practically everything necessary for the construction, leaving nothing, so far as we are able to see, that would need explanation on the part of the drafting department. It also gave the editors about all the data necessary for the writing of this description. The blueprint is of a size convenient for use in the shop, being drawn to a scale of ¾ inch per foot; this is large enough to show all the parts and dimensions clearly. The blueprint measures 17¾ x 22¼ inches within the border lines.



Sixty-ton Flywheel for the Calumet & Hecla Mining Co., built by the Nordberg Engineering Co

EXPERIENCES WITH STEAM TURBINES.

In a paper before the Iowa Electrical Association, Mr. C. E. Stanton gives the results of his operative experience with Curtis four-stage 500-K.W. turbines. The chief difficulties have been in connection with the water supply for the step bearings, the gravity oil supply for lubrication, and the occasional sticking of nozzle valves. All the water for the step bearings in the plant under observation passes through a strainer after leaving the pumps, to remove particles that might clog up the passages of the step bearings or injure the latter. The pumps for the service have fibrous packing and if this is left until it loses its elasticity and becomes soft, small particles find their way into the strainer and soon choke the supply of water to the step bearings. Dirt or particles of packing, when once in the system, may find their way into the strainers, even after many days or weeks, and the strainers must therefore be cleaned at intervals of twenty-four hours.

The hydraulic accumulator for the step bearing system, if allowed to remain in one position for a considerable period of time, was found to rust fast and not drop, even if all the pressure was removed from the steam, thus defeating the object for which the accumulator is intended. It therefore must be tested frequently by allowing the ram to drop slowly and then return to its former position, a test that was made each day. One other precaution that should be taken with accumulators for this work is to have some kind of signal, usually a steam whistle, which will blow if the accumulator starts to come down, thus notifying the engineer of the failure of the oil supply.

In the 500-K.W. turbines there are eight main nozzle valves, each with its individual pilot valve, which is electrically controlled. On any load within the rated capacity of the turbine, running condensing, five valves are all that open, leaving three valves which might not open for days at a time. If these are left long, they will corrode and stick and if a heavy overload should come might not open at all—or if they did open they might remain in this position. To obviate these troubles all valves are opened and closed several times each day when starting the turbines. Some difficulty was experienced in securing suitable packing for the main nozzle valves which would stand a high degree of superheat. Metallic packing was not successful and asbestos ring packing is now employed, which is satisfactory, except that the valve stems must be repacked more frequently than would be the case if metallic packing could be used.

The difficulty in lubrication arose through an air lock formed in the gravity oil tank, allowing air to come into the oil feeder pipe line and interfere with the flow of the oil. This would cause an intermittent flow of oil at times, but the trouble was remedied by venting the top of the tank. Attention is called by Mr. Stanton to the necessity, when regulating the turbines, for having the plates of the step bearing lined perfectly and free to adjust themselves and also of the same diameter to avoid the formation of a fin around the outer periphery of either of the plates. It was found also that the steady bearing which is directly above the step bearing should be thoroughly cleaned and examined for any rough spots before being put in place. This bearing consists of a tapered sleeve which fits in a corresponding tapered hole in the base of the turbine. If it does not seat perfectly, owing to dirt or rough spots, it will work loose and cannot be held in place. In all cases where trouble has been had with this bearing it was found to be due to dirt, bruises or metal chips. Two kinds of middle and top bearings were tried. First both of these were solid shells, held rigidly in place; but at present bearings of the spring type are employed and these springs have had to be renewed several times.

The difficulties experienced in the operation of these turbines have been very slight, as indicated by the foregoing, and have had to do quite as much with auxiliaries as with the turbines themselves. Mr. Stanton concludes his paper with the statement that the turbine has upset many of the hard and fast principles of the Corliss engine builder and is doubtless here to stay. The economy and efficiency of the steam turbine are so pronounced that this type of prime mover is being universally adopted in modern plants for the generation of electrical energy. He said the close regulation of the turbines was a surprise to him and that it is possible to operate the electrical railway and the power and lighting circuits on one set of buss bars without experiencing any trouble with the regulation on other lines.

* * *

SEVENTY YEARS AGO.

At a recent meeting of the New England Cotton Manufacturers' Association, Stephen A. Knight, a veteran in the cotton industry, gave some reminiscences of his early life, which cast an unpleasant light upon the conditions that existed 70 years ago. It almost shocks us, for example, to find that only 70 years ago the working day in some of the mills, at least, was fourteen hours, and that a young boy received only 42 cents a week for his services. We all know that in these days conditions are none too good in textile centers; but they are infinitely better than they used to be. Mr. Knight relates:

In 1835 I began my labors in a cotton mill as bobbin boy, or, as it was termed in those days, back boy. The mill was in the state of Rhode Island, being in the town of Goventry. It was owned by a man who was at one time Governor of Rhode Island, a man who was a progressive and intelligent manufacturer. His mill was "up-to-date" and among the most successful in the country at that time.

My work was to put in the roving on a pair of mules containing 256 spindles. It required three hands—a spinner, a fore side piecer and a back boy—to keep that pair of mules in operation. The spinner who worked alongside with me died about two years ago at the age of one hundred and three years, an evidence that all do not die young who spend their early life in a cotton mill. I am hoping to go him one better.

The running time for that mill, on an average, was about fourteen hours per day. In the summer months we went in as early as we could see, worked about an hour and a half, and then had a half hour for breakfast. At twelve o'colck we had another half hour for dinner, and then we worked until the stars were out.

From September 20 until March 20, we went to work at five o'clock in the morning and came out at eight o'clock at night, having the same hours for meals as in the summer time.

The proprietor of that mill was accustomed to make a contract with his help on the first day of April, for the coming year. That contract was supposed to be sacred, and it was looked upon as a disgrace to ignore the contracts thus made. On one of these anniversaries, a mother with several children suggested to the proprietor that the pay seemed small. The proprietor replied, "You get enough to eat, don't you?" The mother said, "Just enough to keep the wolf from the door." He then remarked, "You get enough clothes to wear, don't you?" to which she answered, "Barely enough to cover our nakedness." "Well," said the proprietor, "we want the rest." And that proprietor, on the whole, was as kind and considerate to his help as was any other manufacturer at that time.

The opportunities for an education among the factory help were exceedingly limited, as you can well see, both from the standpoint of time and from the standpoint of money.

The power of the mill was taken from the north branch of the Pawtuxet river on to a breast wheel, connected with segment gears, to an upright shaft by a pinion gear. The wheel was in about the center of the mill and occupied a space on the first floor, about twenty feet long and about three-quarters of the width of the mill, full height of the first story which was the weaving room. The upright, as well as most of the shafting in the mill, was square, turned only where the bearings came. A main line ran from the upright each way and was driven by a crown wheel and bevel pinion.

The upright ran up through the entire mill. The driving pulleys, or, more properly speaking, the drums were wood with iron clamps to connect them to the shafting, made tight and trued up with iron wedges. The belting was made by the overseer in each room from sides of leather just as it came from the tannery.

SURVEYING WITHOUT INSTRUMENTS.

A. L. DE LEEUW.

This subject may seem somewhat out of place in a magazine which deals almost exclusively with machinery, but it is really not more so than a description of shop buildings. It happens quite frequently that the shop man has to do some surveying on a small scale, in order to locate new buildings, or an industrial track, or, perhaps, for some other purpose. Surveyor's instruments are not always at hand, and even if they are the shop man does not always know how to make use of them. I, myself, have had some use of the following kinks, and, although the result is not reliable to a sixty-fourth of an inch, such accuracy is not at all required in those cases where I would recommend the methods explained. By saying "surveying without instruments," I do not mean that no tools at all are required, but that the work can be done without the ordinary surveyor's instruments, and without knowing how to handle them. I propose to give some examples, and to leave it to the reader to find others, and to find his own solutions.

Problem 1.—To find the distance from a point, *A*, to another point, *P*, which is visible but inaccessible. (See Fig. 1.)

As in all other problems, it is supposed that a few stakes, plenty of light rope, and a tape line are handy. Other instruments are not required.

Fig. 1 shows the proceedings. First drive a stake at *A*. Then place another one, *B*, in line with *A* and *P*. Measure the distance from *A* to *B*, by means of the tape line. Next, place another stake somewhere at *C*, and still another one somewhere at *E*, between *A* and *C*. Stretch the rope, *BC*, and move a stake along this rope, until it comes in line with *E* and *P*. This stake is marked *D* in the drawing. Measure the distances *AE*, *CE*, *CD*, *BD* and *AB*. These distances are called in the drawing *b*, *c*, *d*, *e* and *a*.

According to a well-known proposition:

$$AE \times CD \times PB = CE \times DB \times PA. \quad \text{(See Note 1.)}$$

$$bd\,(x - a) = cex.$$

$$bdx - abd = cex.$$

$$abd = (bd - ce)\,x.$$

$$x = \frac{abd}{bd - ce}.$$

Problem 2.—To find the distance between two points, *P* and *Q*; both visible but inaccessible. (See Fig. 2.)

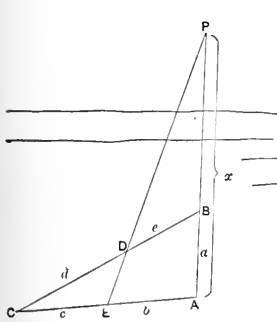


Fig. 1.

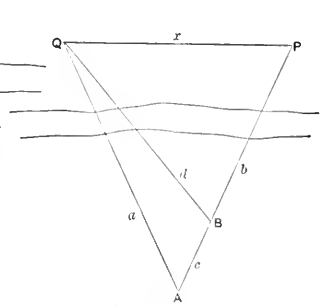


Fig. 2.

Select a point *A* and find the distances from this point to *P* and *Q*, according to the procedure of problem No. 1. Further, select a point *B*, in line with *A* and *P* (or *A* and *Q*, as may seem best). Then find the distance from *B* to the other point (*Q* in this case), also according to the proceeding of problem No. 1. The following lines are then known in the triangle *APQ*: *AB*, *BP*, *BQ* and *AQ*, which are called *c*, *b*, *d* and *a* in the drawing. In order to find the distance *PQ*, we apply a formula which is not nearly so well known as it should be, for it is a very handy one. This formula, or rather proposition, is that when a line *QB* is drawn from a point of a triangle to a point of the opposite side, then

$$QB^2 \times AP = PQ^2 \times AB + AQ^2 \times BP - AB \times PB \times AP.$$

(See Note 2.)

As the only unknown quantity in this case is the line *PQ*, it will be easy to find it by means of the foregoing formula.

Problem 3. To find the distance from a point, *A*, to another point, *P*, which is invisible from *A*. (See Fig. 3.)

It is assumed here that *P* is visible from some other point *B*, and that this point *B* is also accessible. Measure the distances *PB*, *PC*, *BC* and *AC*. It will be easily seen that this brings the problem back to the previous one, as *PC* is a line drawn in a triangle from an apex to a point of the opposite side.

Problem 4.—To find the distance from a point *A* to a point *P*, which is both invisible and inaccessible from the point *A*. (See Fig. 4.)

Select two points, *C* and *D*, from which *P* can be seen. Find the distances *PD* and *PC* according to problem No. 1, and measure the lines *AC*, *AD* and *CD* with the tape line. As all

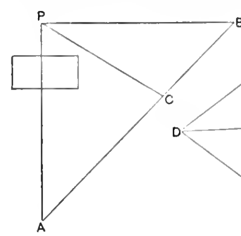


Fig. 3.

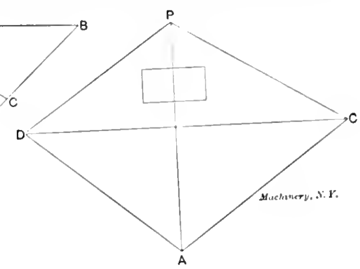


Fig. 4.

sides of triangles *CDP* and *CDA* are known, it is easy to find angles *PDC* and *ADC*. Adding these two angles gives angle *PDA*, and this, with the lines *PD* and *AD* gives us the necessary elements to figure line *AP*.

Problem 5.—To find the distance between two inaccessible points, *P* and *Q*, which are not visible at the same time from one point.

Select a point *A*, and find the distance from this point to both points *P* and *Q*, according to problem No. 4. Select also another point *B*, and do the same; and then measure the distance *AB*. As the drawing shows, the following lines are now known: *PA*, *PB*, *QA*, *QB* and *AB*.

In triangle *PBA*, find angle *PBA*. In triangle *QBA*, find angle *QBA*. The difference between these two angles is *PBQ*. This angle, with the two sides *PB* and *QB*, makes it possible to find *PQ* in triangle *PQB*.

Problem 6.—To draw a line from a given point *A*, perpendicular to the line between two visible but inaccessible points, *P* and *Q*. (See Fig. 6.)

First find the distances from the point *A* to both points *P* and *Q*. Then take an arbitrary point *B*, in line with *A* and *P*, and measure the distance *AB*. Now find a point *C* in line with *A* and *Q*, so that line *BC* will be parallel with *PQ*. For this purpose *AC* must be made of such a length that it is the fourth proportional to *AP*, *AB*, and *AQ*. A line should now be stretched between *B* and *C*. A line, drawn perpendicular to *BC*, will also be perpendicular to *PQ*. In order to draw this line, the point *D* must be located. It is well known that

$$AC^2 - AB^2 = CD^2 - BD^2.$$

This might be written thus:

$$AC^2 - AB^2 = (CD + BD) \times (CD - BD).$$

$$CD - BD = \frac{AC^2 - AB^2}{BC}$$

Knowing the sum and the difference between *CD* and *BD*, either can be found. The line going through *A* and *D* will be perpendicular to *PQ*.

It should be noted that this solution also shows how to draw a line going through a given point, and parallel with the line *PQ*, going through two visible but inaccessible points.

I used problem No. 1 at one time as the basis for a range finder, to be used by the military for field practice. It was given a trial, and proved quite successful. The apparatus consisted of an endless rope, to which three rings were attached at *A*, *B* and *C*, Fig. 7. When stretched, the rope assumed the shape of a right angle triangle; as the three parts

of the rope were 45, 60 and 75 yards respectively. Another ring was attached to the center of BC. A number of brass tags were hung from different points of AC. The mode of operating was as follows: Suppose it was desired to find the distance from A to P. Three men would take hold of the endless rope, by the rings at A, B and C. The first man would place himself in position at the point A. The second man would swing around until called to a halt by the first. This would happen when he was in line with A and P. The third man would then stretch the two remaining legs of the triangle. A stake or rod was held through the ring at E. The man who was to find the range would then take a gun, to which a small plumb bob was hung. He would place himself somewhere in the line AC, where he could sight with the gun over the points D and P. The plumb bob would drop over or near a tag, and he would take note of which tag it was. He would then put the gun down and read the tag. The tag gave him the distance from A to P in yards. The whole proceeding did not quite take a minute from the moment the rope was unfolded until the result was reached. The fact that four men were required was no objection in military field practice. Distances of 1,000 yards could be estimated with more than sufficient accuracy.

Notes.

Note 1.—The proposition used to solve problem No. 1 is known as the theorem of Ceva, and is about 2,300 years old. It forms the basis of an important chapter of geometry, but it is not often taught in schools and colleges. It has become a habit, confirmed by centuries, to teach geometry as it was taught in the days of Euclid. The continental countries of Europe have emancipated themselves in this respect; but England, and, to a very large extent, America, also is still bowing down before the propositions of Euclid. That his propositions are poorly arranged, a number of his demonstrations unnecessarily lengthy, and many of his definitions faulty and that, therefore, geometry misses its aim in the education of the young man or woman, namely, to develop keen and logical reasoning, seems to be of no importance. Euclid did it this way, and this is the way it must be done to the end of days. I believe that geometry is the only thing that has been standing still for more than 2,000 years in countries otherwise civilized. It is true that some schools follow the modified course of Legendre; but his system is

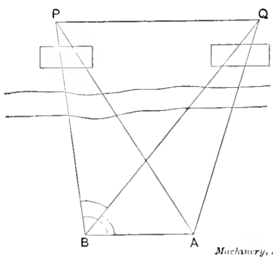


Fig. 5.

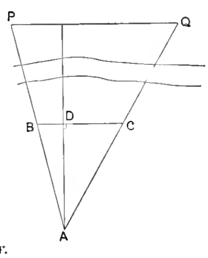


Fig. 6.

not better than that of Euclid. I do not wish to be understood as slighting the merits of either Euclid or Legendre. Either of the two was a very much better mathematician than I can ever hope to be. But they were pioneers; and we should not be satisfied with the work of pioneers several hundred or thousand years after they have died. I believe that this lack of progress, and also the lack of pure logic, are causes which make geometry unpopular, and which rob it of its educational value.

However, I am drifting away from my subject, which was supposed to be the demonstration of the theorem of Ceva. (See Fig. 8.)

ABC is a triangle, and DEF is a line intersecting the sides of the triangle, or their extensions. It should be demonstrated that

$AF \times CE \times BD = AD \times BE \times CF.$

In order to prove this, draw line BG parallel to AC. The triangles DBG and DAF are similar, and therefore,

$DB : DA = GB : AF.$ (1)

The triangles GBE and CFE are also similar so that

$GB : CF = BE : CE$ (2)

Multiplying equations (1) and (2) we find

$BD \times GB : DA \times CF = GB \times BE : AF \times CE$ or

$DB \times GB \times AF \times CE = DA \times CF \times GB \times BE$ or

$AF \times CE \times BD = AD \times BE \times CF$, which was to be demonstrated.

Note 2.—The proposition used for the solution of problem No. 2 is what is known as the theorem of Stewart. The most common way of demonstrating this proposition is by means of the theorem of Pythagoras.

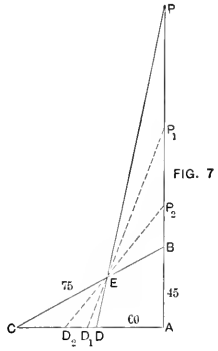
If, in a triangle ABC, Fig. 9, a line is drawn from C to a point D of the line AB (or its extension) then

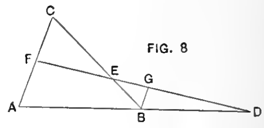
$CD^2 \times AB = AC^2 \times BD + BC^2 \times AD - AD \times BD \times AB.$

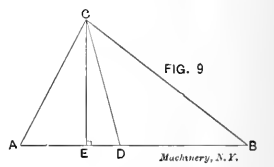
Draw CE perpendicular to AB. Applying the theorem of Pythagoras to triangle ADC, we find

$CD^2 = AC^2 + AD^2 - 2AD \times AE.$

Multiplying this expression by BD, we find







$CD^2 \times BD = AC^2 \times BD + AD^2 \times BD - 2AD \times BD \times AE.$ (1)

In triangle BCD we find:

$CD^2 = BC^2 + BD^2 - 2BE \times BD.$

Multiplying by AD, we find

$CD^2 \times AD = BC^2 \times AD + BD^2 \times AD - 2BE \times BD \times AD.$ (2)

Adding expressions (1) and (2), we find

$CD^2 (AD + BD) = AC^2 \times BD + BC^2 \times AD + (AD^2 \times BD + BD^2 \times AD) - 2AD \times BD \times (AE + BE) = CD^2 \times AB = AC^2 \times BD + BC^2 \times AD + AD \times BD \times AB - 2AD \times BD \times AB.$

$CD^2 \times AB = AC^2 \times BD + BC^2 \times AD - AD \times BD \times AB,$

which was to be demonstrated.

* * *

Tantalum is one of the hardest metals known and up to within a few years ago it was not produced in any other but powder form. The Siemens & Halske Co. have succeeded in producing it commercially in sheets and bars, but it is so hard as to be unworkable with tools, even the diamond not being able to cut it except very slowly. This being the fact, it is remarkable that the production of the incandescent lamp, in which a filament of tantalum of considerable length is used instead of the carbon filament as is usual in the incandescent lamp, is possible. The ordinary method of drawing metals would not apply to tantalum, so that the production of the filament would seem to be an impossibility by ordinary metal-working processes. The filament is made by the squirting process, we understand, the same as the carbon filament of electric lamps is produced. The powdered tantalum is mixed with water and gum tragacanth, in which composition it is forced out into rods or threads as desired, and is afterwards heated to incandescence so that it fuses together into a solid wire. The gum tragacanth prevents the powdered tantalum packing into a solid mass under the press as it would do otherwise.

* * *

The contract for the construction of the immense terminal station of the Pennsylvania Railroad in New York City has been awarded to the Geo. A. Fuller Co., and is to be completed in four years at a cost of \$25,000,000, exclusive of the site. It covers four blocks bounded by Seventh and Ninth Avenues and 31st and 33d Streets.

FREE ALCOHOL AND ITS EFFECT ON INDUSTRIAL CONDITIONS.

The bill making denaturized alcohol free from government ıx has been passed by Congress and with the President's gnature becomes a law January 1, 1907. The removal of ıe tax means a reduction of $1.10 per proof gallon, the proof ıllon being 50 per cent pure alcohol. Hence on 90 per cent lcohol the government tax is $1.98 per gallon. It is exected with the government tax abated the cost to the conımer may be as low as 15 to 20 cents per gallon, 90 per cent roof. Pure ethyl or grain alcohol has a calorific value of bout 28,500 B. T. U. per pound and a gallon of 90 per cent lcohol having a specific gravity of 0.833 contains nearly 00,000 B. T. U. or the equivalent in calorific value of nearly) pounds of crude petroleum.

It is unsafe to predict just what effect free alcohol will ave on the industries of the United States but it is reasonbly sure it will be of tremendous importance and a great oon to our people in general, judging by what has been done ith it in Germany. Its use in large quantities would make au important source of income to the agricultural class as rain alcohol may be derived from products which have been ırgely waste, as was pointed out by Mr. James Wilson, Secetary of Agriculture in his communication on the subject to ıe Congressional Committee on Ways and Means. But, the ıief source will probably be potatoes and other root crops ch in starch which are easily and cheaply produced. It will e a double benefit to the farmer as it will not only give him market for crops of this class but will also give him a fuel ır internal combustion engines and for cooking that is ıeaper than gasoline at the present price. This is especially ınportant in the prairie regions of the West where fuel is igh and where gasoline is now being largely used for both ooking and power purposes. It is also promised that alcohol ill become an important competitor of kerosene in the matter f lighting, although the opponents of free alcohol claim ıat its advantage in this respect will be found disappointıg. The alcohol lamp is not of the simple construction of ıe kerosene lamp but requires the use of a Welsbach mantle ı order to make the same luminous. If this is the only erious difficulty it is not of great importance but is rather a advantage as it will result in the production of a light uch richer in white rays than is possible to obtain with ıe kerosene lamp.

Regarding the use of alcohol in internal combustion enines it is claimed by those who have had experience that it ın be used in gasoline engines with no change whatever ı mechanism. Recent tests made by a member of the Autoobile Club of America demonstrated this fact although they lso demonstrated that a special carbureter is desirable inasıuch as it is necessary to first heat the alcohol in the carureter to a considerable temperature for some time before gives off sufficient vapor for operating the engine. One rawback to the use of pure alcohol in internal combustion ıgines is that it has a tendency to oxidize the interior workıg surfaces when left standing. For this reason a small ercentage of gasoline mixed with the alcohol is advisable as not only overcomes the oxidation but also increases the ıermal efficiency of both products.

It is greatly to be hoped that free alcohol will fulfill the osy future predicted, for it has one great advantage, economically considered, that is lacking in any other fuel except ood, and that is its perennial reproduction. It is comparavely easy to predict the ultimate exhaustion of any natural ıel, such as coal, petroleum and natural gas for none of ıese so far as we know are being manufactured by natural rocesses now but are simply deposits produced in a former eological age. Also the possible concentration of these natıral resources in the hands of a few capitalists puts an enorıous monopolistic power in the hands of a few, a condition ıat must inevitably be detrimental to the interests of the ountry. Not so with alcohol; it can be produced every'here where grain or vegetables can be grown and its manuıcture is so simple that even the ignorant moonshiners of Kentucky and Tennessee are able to produce it.

If free alcohol accomplishes only one thing and that is the substitution of grain alcohol for wood alcohol in the manufacture of shellac and other materials used by painters, pattern makers and others, it will have effected a great good. Many painters have been seriously poisoned and have even lost their eyesight by the use of shellac containing wood alcohol. The danger of its use has long been recognized by these trades and it is to a little band of painters in Massachusetts that we are indebted for this last strong movement which has finally resulted in giving us denaturized alcohol tax free. They interested Mr. Elihu Thompson, of the General Electric Co., in their movement, and his work before the Congressional Committee of Ways and Means had an important influence in gaining it the recognition that it deserved. Prof. Thompson's argument before this committee is of so much interest that we give it below in full.

ALCOHOL AS A MOTOR FUEL.

The importance of cheap alcohol as a fuel for internal combustion engines is not so generally realized as it should be. The increasing use of this type of engine, operated generally by gasoline as a fuel, is evident to everyone. By it there is furnished a power for all purposes which requires the minimum of attendance during the operation of the engine and no preparation before starting. As an engine for farm purposes the explosion type or internal combustion engine is ideal, and its general application to automobiles is already an evidence of its great convenience and effectiveness.

The use of gasoline as the fuel for such an engine is, however, subject to some disadvantages as compared with the employment of alcohol. In the first place the possible supply of gasoline is limited, and its increasing use must inevitably result in a very undesirable increase of price. It is a sort of by-product of the oil industry, and its price has already increased and will probably continue to increase. This is particularly true for the better or higher qualities. Gasoline is more volatile than alcohol, having a much lower boiling point, and is therefore proportionately more dangerous, especially in warm weather. The flame of burning gasoline is highly luminous and one which radiates heat rapidly, whereas the alcohol flame is a faint blue or an almost nonluminous flame, which does not radiate heat to any great extent. The consequence of this is that a mass of burning gasoline will radiate sufficient heat to set fire to things at a distance from it, while heat from burning alcohol goes upward, mostly in the hot gases which rise from the flame.

The case may be illustrated by comparing the flame of the burning pine log in an open fireplace with that of ordinary gas mixed with air in a fireplace. The flame from the burning pine log contains sufficient carbon to radiate the heat freely into the room from the fireplace, whereas the blue flame from the gas requires the assistance of a radiator heated thereby, generally known as a gas log, often composed of minerals, such as asbestos and the like, made red-hot by the blue or non-luminous gas flame. On this account alcohol is a safer fuel than gasoline, as the gasoline can set fire by pure radiation where alcohol would not. Gasoline, as well as kerosene, has the great disadvantage that it floats upon water and is distributed by water. It is a well-known fact that it is comparatively useless to attempt to extinguish burning gasoline or kerosene by water alone. The use of water may, in fact, be a positive disadvantage in floating the burning material over considerable places in spreading fire. Not so with alcohol, which mixes with water in all portions, and which is at once diluted and prevented from remaining combustible.

We have recently tested here at the works of the General Electric Co., in Lynn, a Deutz alcohol engine, a type of engine made in Germany especially for use with alcohol, and the results have been such as to prove without doubt the entire suitability of alcohol, if cheap enough, as a fuel for internalcombustion engines. This particular engine is to be sent to the island of Cuba and coupled to a dynamo for lighting. It will be operated with the cheap Cuban alcohol, which is, I am informed, sold there at about 12 to 15 cents per gallon. A few gallons of this alcohol were obtained and used in our tests here, and it was found to be a high-grade spirit containing 94 per cent alcohol by volume and 6 per cent of water.

or about 90 per cent alcohol by weight. While it is not methylated or denatured, there is no question that the behavior in the engine of denatured or methylated spirit would be identically the same as with the pure grain alcohol.

To obtain this sample of Cuban alcohol it was necessary that we pay an import tax of $4 per gallon, with other charges, which made the cost of the material used in testing enormous as compared with its actual value in Cuba, and I may here remark that, as in testing an engine of this kind a considerable quantity of alcohol will be used, manufacturers here in the United States would suffer a considerable disadvantage in building such engines as compared with those in a country where methylated spirit, untaxed, is obtainable. In fact, the cost of the material for testing the engines is probably a sufficiently strong deterrent just now to prevent the manufacture being taken up in the United States. The island of Cuba is, however, an excellent field for the use of such machinery, on account of the low cost of alcohol.

It may be mentioned here that our experiments developed the fact that alcohol is suitable as a motor fuel even when it contains as high a percentage as 15 per cent of water. Notwithstanding the fact that the heating value of alcohol, or the number of heat units contained, is much less than that in gasoline, it is found by actual experiment that a gallon of alcohol will develop substantially the same power in an internal-combustion engine as a gallon of gasoline. This is owing to the superior efficiency of operation when alcohol is used. Less of the heat is thrown away in waste gases and in the water jacket.

The mixture of alcohol vapor with air stands a much higher compression than does gasoline and air without premature explosion, and this is one of the main factors in giving a greater efficiency. It follows from this that, with alcohol at the same price as gasoline, the amount of power developed and the cost of the power will be relatively the same so far as fuel itself is concerned, but on account of the higher efficiency of the alcohol less cooling water is required, or a less percentage of the heat of combustion is communicated to the cylinder walls of the engine. The exhaust gases from the alcohol engine carry off less heat. They are cooler gases.

It is well known that the exhaust gases from a gasoline or kerosene engine are liable to be very objectionable on account of the odor. In our tests of the Deutz alcohol engine here there was absolutely no such objection with alcohol fuel, the exhaust gases being but slightly odorous, or nearly inodoreus, and what odor there was was not of a disagreeable character. Our experiments with the burning of alcohol as a motor fuel also showed us that alcohol possesses a considerable tolerance as to the richness, or the reverse, of the mixture in the engine, and that even when there was considerable excess of alcohol for the air the exhaust was not disagreeable in odor, a condition which with either gasoline or kerosene leads to a smoky, badly smelling exhaust. The importance of a fuel which does not produce disagreeable exhaust gas is greatest in the case of stationary engines of considerable power, as in that case the exhaust is emitted in one locality and may become a source of nuisance. This has often been experienced with gasoline or kerosene engines and has tended greatly to limit their application, particularly in densely built-up sections.

There is just now the beginning of a large development in the application of the internal-combustion engine to the propulsion of railway cars on short lines as feeders to the main lines. In this case an ordinary passenger railway car is equipped with a power compartment at one end, in which power compartment there will be installed an engine of, say, 200 horse power of the internal-combustion or explosion type. The growth of such a system is liable to be hampered in the near future by the cost of gasoline as a fuel, and the difficulties of using kerosene are still quite considerable. Especially is the exhaust likely to be offensive. In this case alcohol, which could be produced in unlimited amount, could be substituted.

A large variety of agricultural products are easily capable of being converted into alcohol, and such products as are unmarketable, either from overabundance of crops or defective growth or damage are still available as sources. Hence each agricultural district would be able to supply itself with all the motor fuel needed, and at the same time produce for other districts. Inasmuch as alcohol can be stored in tanks for an indefinite period without change of its nature, any surplus production of alcohol can easily be taken care of. Speaking with a prominent beet-root sugar manufacturer, he gave it as his opinion that from the wastes of the beet-root sugar industry alcohol could be produced at a cost of about 10 to 12 cents per gallon. It is probably true that from other agricultural wastes, such as fruit parings, fruit partly decayed, surplus corn, etc., a cost equally low might be realized.

It is easily possible to convey alcohol by a pipe line, and its very limpidity or liquidity facilitates the process of pumping it through a line. It is reasonable to infer that, freed from tax, there is no possible substitute for this valuable fuel which could be supplied at such a low cost. It may be mentioned in conclusion that the efficiency—that is, the ratio of the conversion of the heat units contained in the fuel into power—is probably higher in the alcohol engine than in engines operated with any other combustible, and doubtless, on account of the comparative newness of the alcohol engines, there is still room for some improvement in this respect.

* * *

A HEATING PROBLEM.

The heating and ventilating of a church auditorium has always been an interesting problem, for there are conditions found, and difficulties to overcome, in an auditorium of this kind that do not occur in the ordinary building, such as large glass surfaces, which are the source of cold drafts, little floor space for placing radiators, and the fact that radiators near seats make those seats undesirable.

In the case of the Broadway Tabernacle, New York, there was a serious difficulty to contend with, namely, that under the auditorium there is a hall, which had to be left free of pipes and other objectionable features from an esthetic point of view; in other words, there is no cellar in which pipes and ducts could be placed. A space between the auditorium and the ceiling below was provided for this purpose. This space is about three feet deep, but as it is due to the depth of the girders that carry the floor its usefulness for placing pipes and ducts was limited, as can readily be understood.

After carefully considering all these points it was decided to use the blast system of heating, with mechanical exhaust and automatic temperature control for the auditorium, and direct radiators controlled by hand for the vestibules. The seating capacity of this auditorium is 1,500. The apparatus was designed to supply 25 cubic feet of air a minute per person to 1,600 persons, or a total of 40,000 cubic feet of air a minute.

It may be mentioned that in this case 25 cubic feet a minute per person was about the maximum amount of air that could be introduced without causing drafts and noise, and a large proportion of this air had to enter through top inlets. The entire use of bottom inlets would have been impossible without causing drafts, or considerably reducing the amount of air supplied. A three-quarter housed centrifugal fan, built by the B. F. Sturtevant Co., Boston, Mass., is used to supply the air. This fan has a blast wheel 9 feet in diameter by 4½ feet wide, and is driven by a direct connected motor. The fan is calculated to deliver 40,000 cubic feet of air a minute at 130 R. P. M.

* * *

In the manufacture of large gate valves much trouble has been experienced because of the liability of cracking the valve casting at the corners, especially under heavy pressures. For a long time it was attempted to correct this trouble by strengthening the castings at the corners. But after some costly experiments in this direction and after analyzing the matter it was concluded that the trouble was not due to lack of strength in the corners of the casting so much as to lack of stiffness in the sides, which, being unsupported, deflected outward under the water pressure and thus broke the castings at the corners because of the great leverage effect. This fact having become known, the obvious thing to do was to stiffen the side walls in the center, so that they would have the same characteristics as a stiff girder and thus be able to resist the pressure with small deflection. This obviated the difficulty.

SOME PROGRESS IN SIMPLE PRESS WORK.

H. J. BACHMANN.

In the phenomenally rapid progress made during the last decade in the press working of sheet metals by the introduction of compound, combination, sub-press, and gang dies, automatic roller and dial feeds, the simpler operations on the power press, instead of becoming subject to similar improvement, have been sadly neglected.

It is of these simple things, the basic elements of the art, that I wish to speak of in this article. Although the discussion applies principally to a single representative line of presses extensively used in this country, viz: Bliss, Nos. 19, 20 and 21, still the suggestions brought forward may be applied with slight modifications to any make of upright power press on the market to-day.

It is not so generally known as it should be that the ability to incline a press adds materially to its productive capacity. This advantage is almost doubled when the same belt may be used in both positions, permitting the change to be readily made without undue loss of time. I have, during my somewhat limited experience in this line, made it a rule to incline the press on all operations except "push through" jobs, that is, on all work which does not drop through the bed of the press. It is then simply necessary to feed the work to the dies, allowing it to drop out by gravity. To permit the use of the same belt for both positions, the press should be so placed on the floor that the center of the shaft when in its inclined position is the same distance from the line shaft as it is when the press is upright.

While there are many diemakers who advocate the use of a separate cast iron bolster for each die, I have been converted to bolsters made of cast steel which are largely used by Western shops. There are two made for each press, one for cutting dies and one for bending and forming dies, the construction of compound and combination dies remaining unchanged. By this system the separate dies are interchangeable on any press; they occupy less space on the shelves of the tool room, and inasmuch as all strippers and gages are fastened directly to the die instead of to the bolster, they never become lost when changing from one job to another. In this connection I wish to impress upon diemakers the desirability of using standard hex-head cap screws to hold down strippers, gages, etc. The strippers on any die may then be removed to facilitate correct setting of the die, and then replaced in position—something impossible on slotted head screws except by using an angle screw-driver.

There is little room for improvement in the cast-iron punch-holder. I can only suggest the use of solid piercing punches in place of the drill-rod surrounded by a soft steel sleeve riveted to a punch pad. I try wherever possible to do away with this old-fashioned soft steel punch-pad and let the punches into their holders either by turning a round shank on them or dovetailing them into the cast iron in the same manner as the die.

In planing up the die-blank it is well to remember to take a very slight cut from the bottom and a cut about twice as deep from the top. This removes the decarbonized surface from the cutting face where it needs most to be done, but leaves it on the bottom where the die may remain soft. Where there is

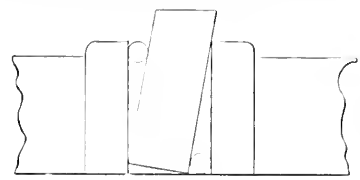


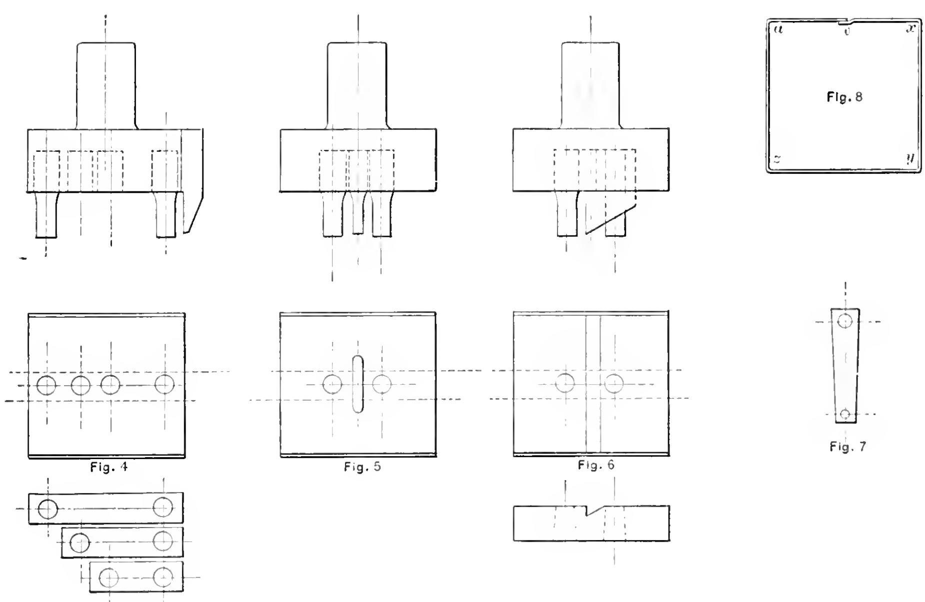
Fig. 1.

Fig. 2.

a scarcity of 10 degree parallels, two pieces of drill rod between the jaws of the vise may be arranged to give the correct angle. Quarter inch drill rod is the size to use when the jaws are 1 9-16 inch high as shown in Fig. 1. Where intricate shapes must be drilled out with small drills the holes may be laid out a trifle close together and the end of an old drill of the same size stuck into the first hole drilled. This will prevent the drill from running too far into the previously drilled hole and by proceeding in this manner all around the outline the core to be removed will drop out without the use of chisel or drift. The amount of draft on some blanking dies which are combinations of drilled holes, as, for instance, the shape in Fig. 2, may be infallibly indicated by reaming these holes from the back of the die with Stubs broaches as though they were simple piercing dies.

Where extreme accuracy is essential, or a die is too large to be made of a single forging, the use of sectional dies becomes imperative. While the first cost of a well-made die of this kind is higher than that of a solid die still the ease of repair and uniformity of production of this type of die make it a winner in the long run.

The above conclusions may seem somewhat radical to some of the older men of the craft but they are not without foundation as some of your recent articles by Mr. Lucas will show. I am afraid there is a lack of initiative among the diemakers



Steps in the Evolution of Press Tools for Making Copper Connectors.

of to-day. They go on making the same old thing in the same old way for the simple reason that they have never seen it done differently and find it impossible to take the responsibility of experimenting on a new idea.

The dies shown in the illustrations serve to emphasize the main features of this discussion. Fig. 4 shows a die as originally made for the three copper connectors shown in Fig. 3. It is a plain cutting-off die having the different holes placed in the die at the proper center distances apart. By means of a suitable adjustable gage and by placing one of the piercing punches in its proper position in the punch-holder, the three different sizes of connectors shown in Fig. 3 may be produced. However, during the process of improvement of the device on which these connectors were used, it became necessary to change the center distances between the holes and also to produce three longer ones. The die shown in Fig. 5 was at first considered adequate, but on account of the quantity required the scrap produced by the cutting punch was considered objectionable. Leaving the piercing punches in the same position, the shape of the cutting off punch was changed as shown in Fig. 6 and a corresponding "V" groove planed in the die. In connection with stripper and gage (not shown) this die allows the production of an indefinite number of connectors of different center distances.

The die shown in Fig. 8 impressed upon me the fact that the slitting shear is a valuable auxiliary to any press. The metal for the production of the copper segment 1/8 inch thick shown in Fig. 7 ordinarily would be cut a little wider than the length of blank so as to allow the punch to cut all around. But in all cases where two sides of a blank are parallel, the stock may be cut the exact width of the parallel portion of the blank in the slitting shear, and then they may be punched and cut off two at each stroke of the press as shown by the sketch of the die in Fig. 8. There is one inherent drawback to this form of die and that is the tendency of the punch to lift up the end blank while cutting it off and produce a badly bevelled edge. But if this portion of the strip is securely held down by the clamping device on the die as shown, the punch will have the same effect on both sides of the blank, cutting it off squarely. The gage and stripper held down by the cap-screws can be made a better fit on the stock than ordinarily because it is not necessary to lift it up past a stop pin fastened to the die to enable the operator to feed the strip. By inclining the press, allowing one blank to slide out when released by the clamp, and letting the punched one drop through, two complete blanks are produced at each stroke of the press with almost no scrap.

The extension punch and die in Figs. 10 and 11, which I have seen in various forms but never in print, is quite useful on work which is commonly beyond the scope of the press, such as the sheet iron box shown in Fig. 9. This forms the sides of a slate bottomed switch cabinet used on the old Manhattan Railway cars when they were equipped with electricity. The operations on this box included the bending of the 2 by 1/4 inch strap iron in four places, forming the lap joint, and riveting same. The sketch shows the punch and die (without necessary stops and gages) in position for bending the corners. The front clamping plate is removed from the ram and the cast steel extension bolted in its place with the same bolts. The large hook bolt extending into the hole in the ram and drawn up by the nut outside, is required to support the extension during the strain of bending. To allow the stock to clear the front of the press when bent into shape the distance "A" on Fig. 11 should be a little more than half the width of the strap iron to be bent, and to avoid fouling the flywheel corner, x on Fig. 9 should be the first one bent after the lap has been formed, and then, in rotation, corners y; z and a. When running the press at its accustomed speed on this job the ends of the bent piece moved rather too fast for comfort and it was

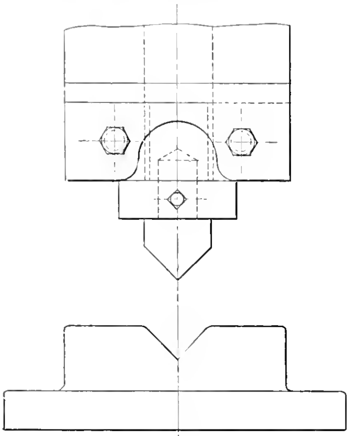


Fig. 10

Die for Corner of Sheet Iron Box.

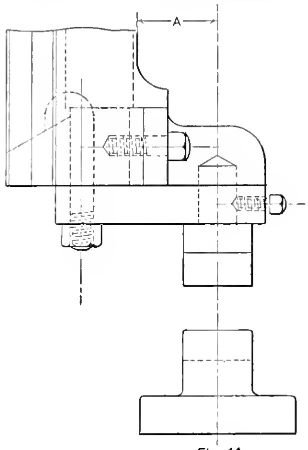


Fig. 11

Side View of Die in Fig. 10.

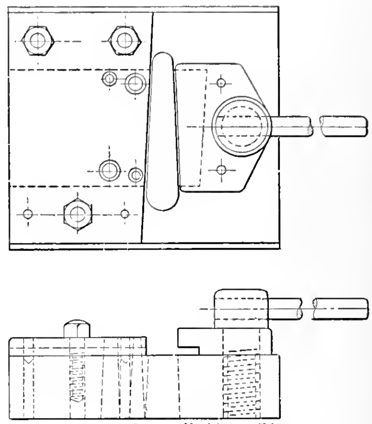


Fig. 9 *Machinery, N.Y.*

A Die for Punching without Waste the Pieces shown in Fig. 7.

therefore necessary to cut down the speed of the flywheel by inserting resistance in the armature circuit of the motor which drove the line shaft to which three of these presses were belted.

Finally, there is one thing more which has just struck me and to which I would like to refer. I had almost forgotten to put in a good word for the clutch lock used on the press which enables the diemaker to set the dies without throwing the belt—a convenience which must be used to be appreciated to its full extent.

* * *

Inasmuch as every structure built of inflammable materials has within itself the potential elements for its own destruction it should also have the elements for subduing fire, which means an independent water supply and means for automatically distributing same to drown out incipient blazes. In other words, every structure of importance which is not fireproof in every particular should be an independent unit so far as fire fighting is concerned, having within itself complete fire fighting apparatus. This lesson was forcibly impressed by the great fire following the earthquake shock in San Francisco in April. That fires should follow such a crash was but a logical consequence but it is doubtful if the fact that such a shock would paralyze the water system by breaking the mains had ever been seriously considered by the city engineers. In all probability the prevention of such disruption of the water system by severe earthquake could not be prevented, but if the principal large buildings in the commercial districts had been provided with generous sized water tanks and sprinkler systems throughout, the fire loss in this part of the city could have been greatly reduced no doubt. The principle of making every large building independent in fire fighting facilities is one that has been adopted by factories generally, but its extension to commercial buildings in large cities has been comparatively slow. When we consider that any city water supply may be temporarily put out of business by a variety of causes any of which may operate at a critical period it seems that the rule, as laid down in the foregoing, should be very strictly enforced.

DESIGNING AND BUILDING A MACHINE PART.

H. P. FAIRFIELD

The machinist is apt to concern himself but little with the steps taken by others to produce the castings which he is given to finish into machine parts. He seldom gives the designer or draftsman a thought, and the patternmaker or molder gets less. It may be of general interest to follow along the path a piece has taken from its first inception in the designer's brain, to the point where it becomes a finished part of a useful machine, and to count the footsteps. Take, for example, a worm gear such as that shown in Fig. 1, which is part of a friction feed mechanism. Topsy "just growed," but this is not true of a machine part, either in design or workmanship, and even so simple a piece as the one shown represents thought by the designer, patternmaker and foundryman. The designing draftsman should be something of a pattern-

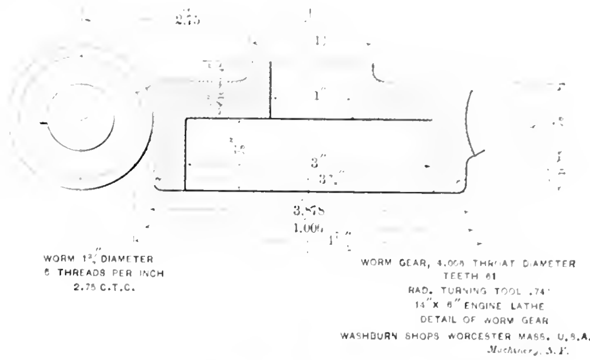


Fig. 1. Drawing of the Worm Gear to be Made.

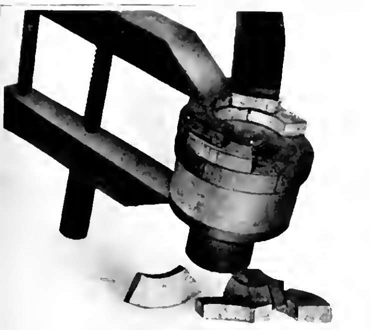


Fig. 2. Gluing Up the Pattern

Fig. 3. The Hub and Finished Face of the Pattern.

Fig. 4. Turning the Wood Chuck to Fit the Pattern.

Fig. 5. Turning the Seat for the Hub.

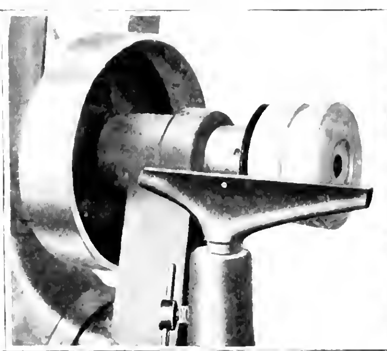


Fig. 6 The Seat Completed

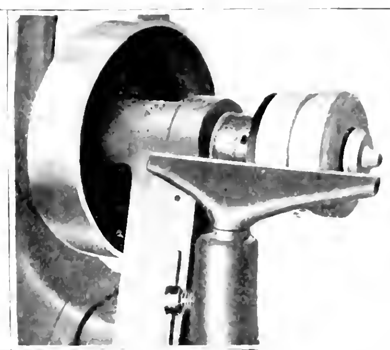


Fig. 7. Trying in the Hub

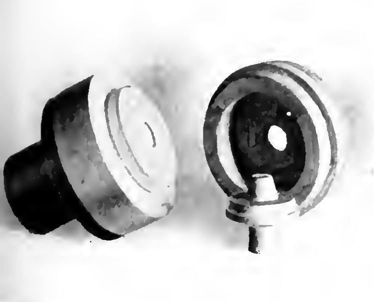


Fig. 8. The Completed Body and Hub.

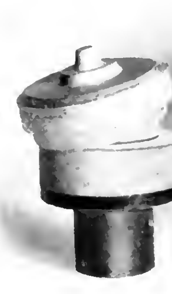


Fig. 9. The Assembled Pattern.

Fig. 10. Pattern Finished and Shellacked

maker, foundryman, and machinist, in addition to his ability to assign proper values to form, strength, velocity ratios, position, etc.

The patternmaker is concerned with questions of shrinkage and warping of the materials used in making the pattern. He is also concerned with the foundry and machine shop problems of shrinkage, draft, finish, ease of molding and machining. Fig. 2 shows the best method of gluing up a pattern to provide for uniform shrinkage, prevent serious change of form by warping, and give strength. Such a pattern finishes nicely under the cutting tool, as shown in Fig. 3. The core print and hub are, however, turned from the solid and after-

ward glued into place. Strips of paper glued between the first layer and the face-plate board allow the pattern to be removed at this stage and the board is shouldered to fit snugly the recess in the pattern, as shown in Fig. 4. Wood mounted on a face plate and afterward used to hold work by gluing, shouldering, recessing or any similar manner is termed a wood chuck, and Fig. 5 shows how the work is held true and firm in this manner. In this position it is trued off and the hub recess turned to a fit. Fig. 6 shows the tool rest swung to a position that allows the hub to be tried into the recess, as in Fig. 7. Fig. 8 is the pattern removed from the chuck with the hub and core prints ready for gluing into place. This shows in Fig. 9, and in Fig. 10 the pattern is shellacked ready for molding. The tools used by the patternmaker appear in Fig. 11.

Considered from the viewpoint of the foundryman, a pattern is a useful but not an indispensable tool, and with it he can more easily produce the required castings. Such a pattern as the one shown makes a simple molding job, if a molding job of any sort can be termed "simple." In Fig. 16 are the two parts of a flask made hinged so as to be snapped open by the molder to remove it from the sand mold, and in Fig. 12 is the sand mold complete with the taper plug that forms the gate in place. Some of the tools used by the molder are shown in this view. For convenience in handling the upper and lower parts of the flask—termed the *Cope* and *Nowel*—as much of the pattern as its shape will allow is bedded into the nowel, as in Fig. 13. With the pattern withdrawn as in Fig. 14, a cavity is left for filling with the melted metal. As a portion of the cavity is in the cope, the flask needs to be closed when poured. To lead the metal into the cavity made by the pattern, a gate is cut beside it out to that left by the tapered plug. This is shown in Fig. 15. To form a hole in the center

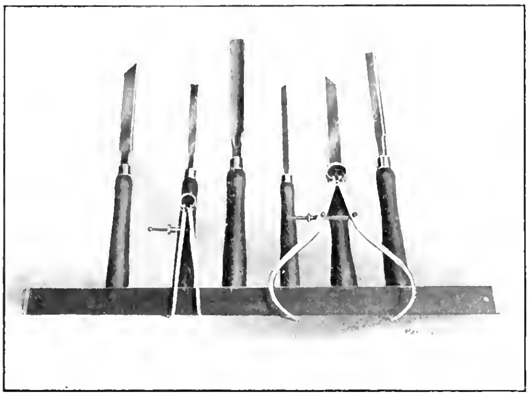


Fig. 11 Tools used by Patternmaker.

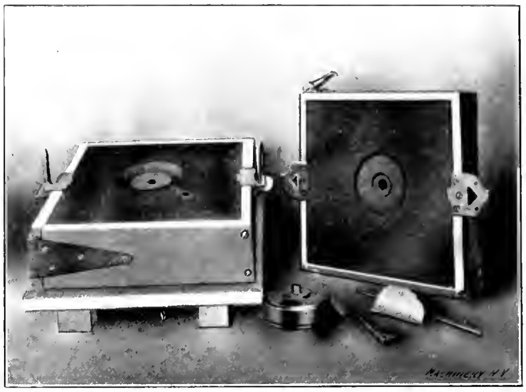


Fig. 14. The Pattern Drawn.

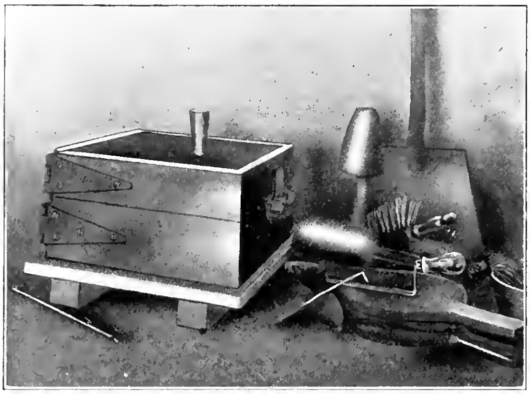


Fig. 12. The Mold and the Molder's Tools.

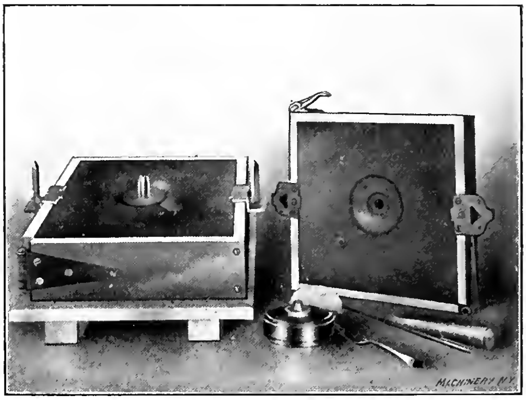


Fig. 15. The Core in Place, ready for Cope.

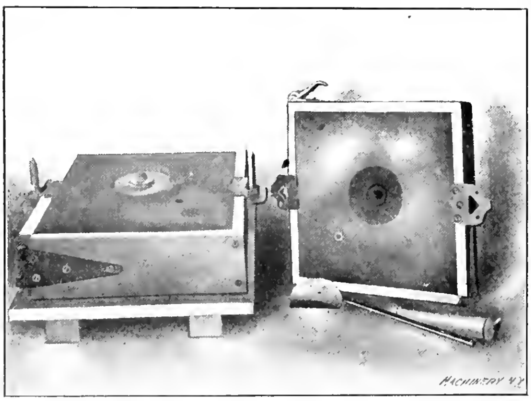


Fig. 13. Ready to Draw the Pattern.

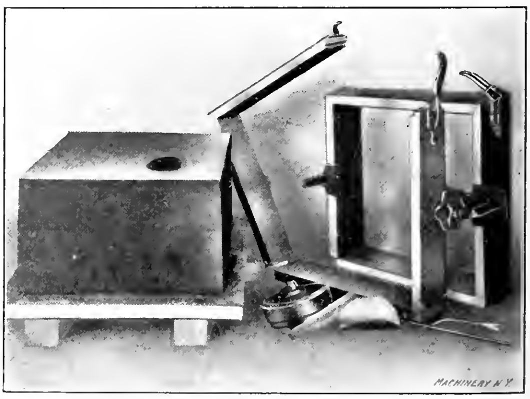


Fig. 16. The Completed Mold.

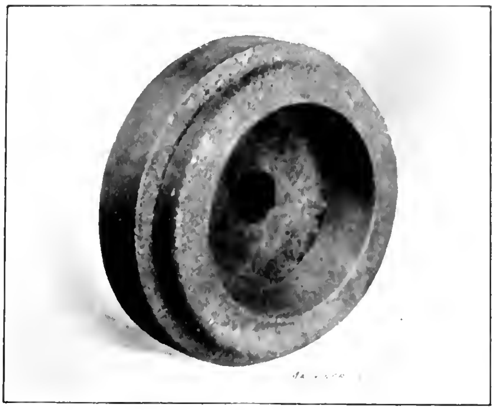


Fig. 17. The Rough Casting.

of the casting a sand core is placed in that part of the cavity left by the core prints, and the mold is closed and the flask removed. The mold now presents the appearance of Fig. 16, and is ready for pouring. It will be seen from this figure that the outer part of the gate has been enlarged to form a basin

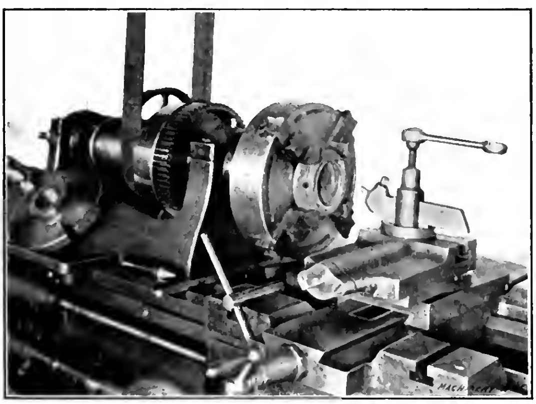


Fig. 18. Truing up the Casting in the Chuck.

into which the molten metal can be conveniently poured. After the mold is poured the sand is broken apart and the casting is allowed to cool until it is ready to be placed upon the pickling bed and prepared for the machine shop processes and appears as in Fig. 17.

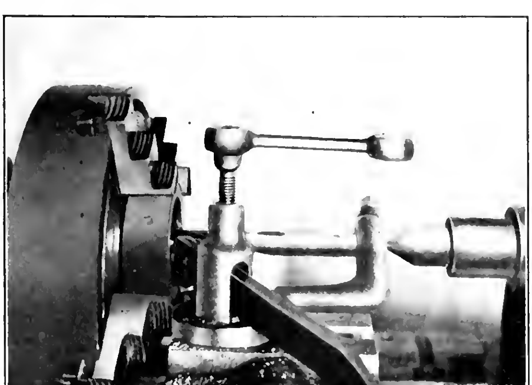


Fig. 19. Drilling Out the Hole.

The first operation on the casting in the machine shop is to true it up in a lathe chuck and finish out the hole. To insure a satisfactory hole three tools are used: a drill, lathe reamer and hand reamer, in the order named, each tool leaving the correct amount of stock for the succeeding one. To indicate the position of eccentricity when truing up the piece in a chuck, either chalk or a lathe tool may be used. Fig. 18 shows the piece ready to be drilled and lathe reamed, Fig. 19 and Fig. 20 completing the operation. If the drill tends to wabble when it is being started, the butt end of a lathe tool held as in Fig. 19 steadies it. The back surface of the recess can be more easily finished when held in the chuck than after-

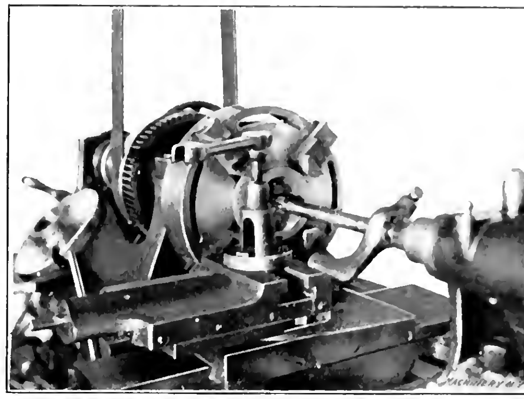


Fig. 20. Reaming the Bore.

ward. Figs. 21 and 22 show this being done. The outer edge is squared first for convenience in scaling the depth of the recess.

Fig. 23 illustrates the finishing of an internal circumference true with the hole. While it was good enough practice to

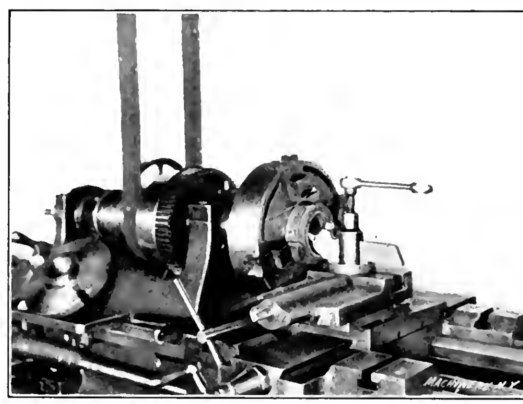


Fig. 21. Roughing the Back of the Recess.

rough out and finish the inner radial surface while the piece was held in the chuck, it is necessary that the split ring bearing and gripping surface be practically true running, and this involves finishing this surface on a true running mandrel.

In roughing out and finishing the outer circumference, as in

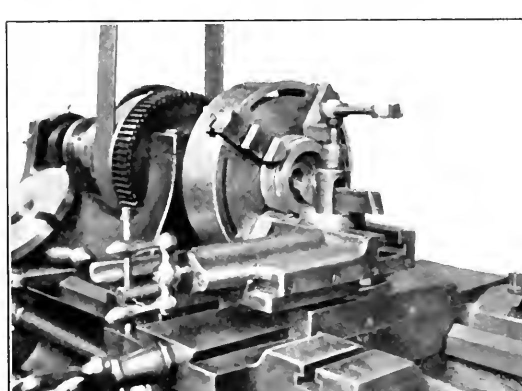


Fig. 22. Finishing the Recess

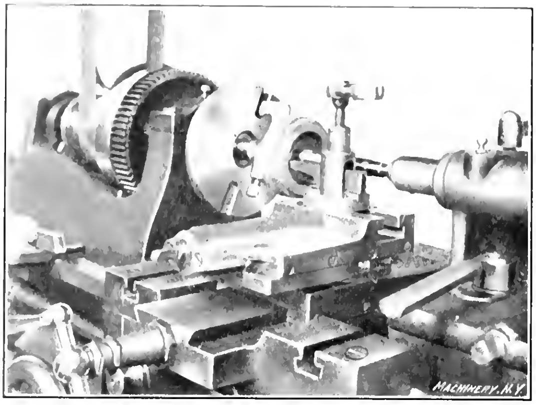


Fig. 23. Finishing the Inner Circumference.

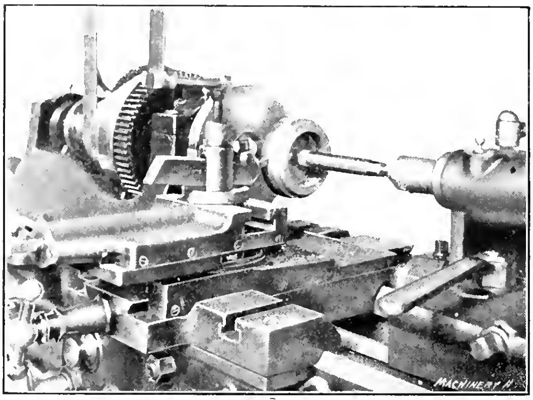


Fig. 24. Rough Turning the Outside Diameter.

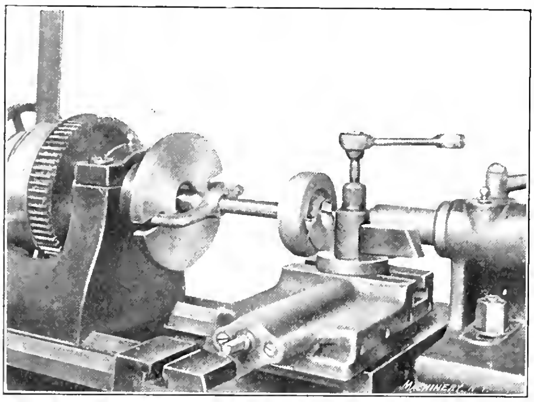


Fig. 25. Roughing the Outer Face.

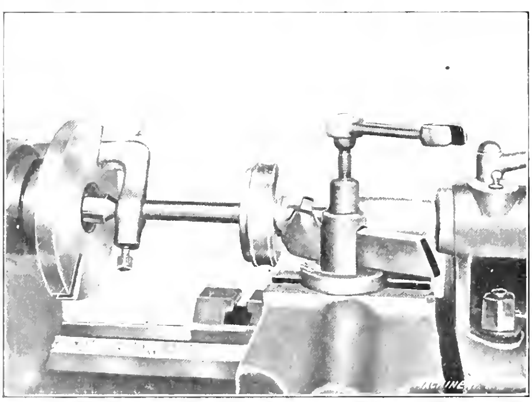


Fig. 26. Finishing the Face with a Scraping Cut.

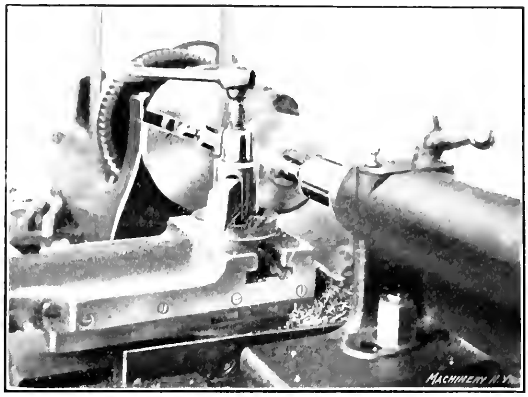


Fig. 27 The Finished Surface.

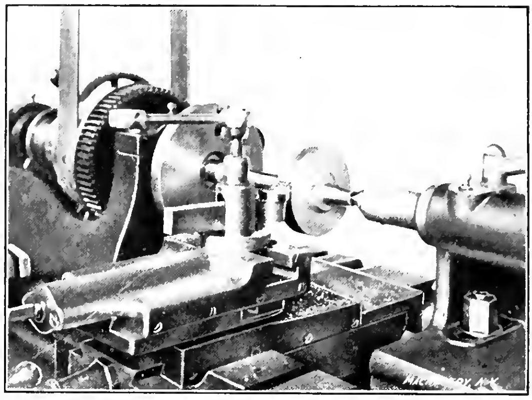


Fig. 28. Radius Tool for Tooth Surface.

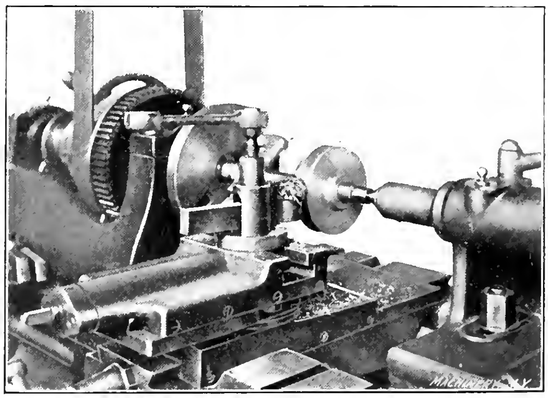


Fig. 29. Chips made by Radius Tool.

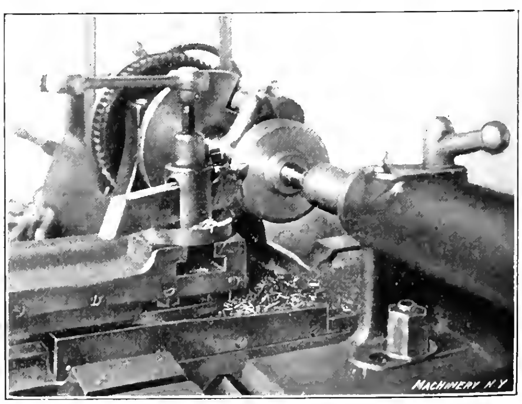


Fig. 30. Chamfering the Corner.

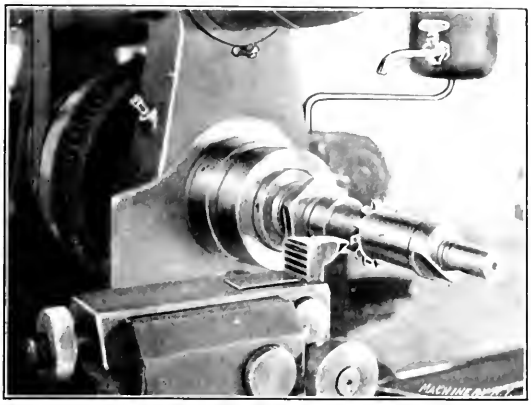


Fig. 31. Centering the Gashing Cutter.

Fig. 24, the concaved surface for the teeth is left as the lathe tool leaves it.

Roughing the outer radial surface, as shown in Fig. 25, is best done by feeding from the outside towards the center, as

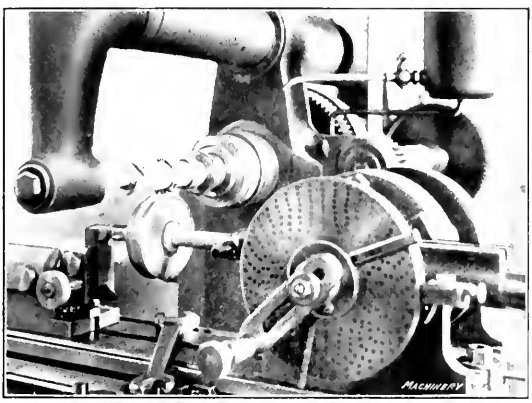


Fig. 32. The Cutter Located with Reference to the Blank

the hard skin or scale of the casting is pried off or crumbles ahead of the cutting edge.

Finishing this surface is done by lathe scraping, which leaves a smooth, polished surface. For this purpose the tool

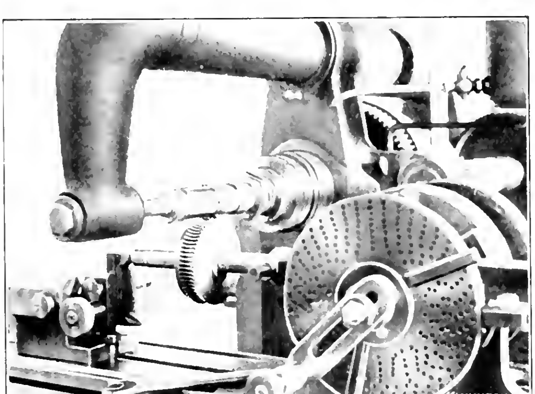


Fig. 33. Gashing the Worm Wheel.

is fed in the reverse direction from that of roughing, or from the center outward. Fig. 26 shows the method and Fig. 27 the results.

The concave surface upon which the teeth are cut is easily made, as in the illustration, Fig. 28, by means of a radius tool. If a comparatively slow speed is used and a firm, steady feed, the tool will not give trouble by chattering. The fact that such a tool removes actual shavings when properly used is clearly shown in Fig. 29. When the corner has been beveled or chamfered, as in Fig. 30, the piece is ready to have the teeth cut on its circumference. Before doing this it may be well to consider briefly the way in which the teeth *may* be cut. Worm gears used as adjustments do not need to have other than line contact between the teeth of the worm and gear, and suitable teeth may be formed by using a single cutter of the proper curvature. This is very clearly shown by the

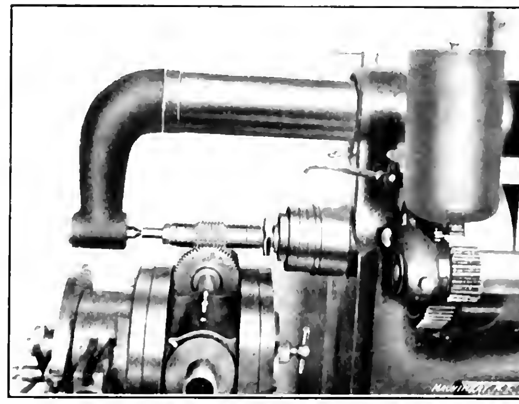


Fig. 34. The Hob in Place.

Brown & Sharpe Mfg. Co., in their treatises on gears and the milling machine. Where, however, the worm and gear are used to move a load, as in the case of a feed works drive, surface contact between the teeth is made necessary. To

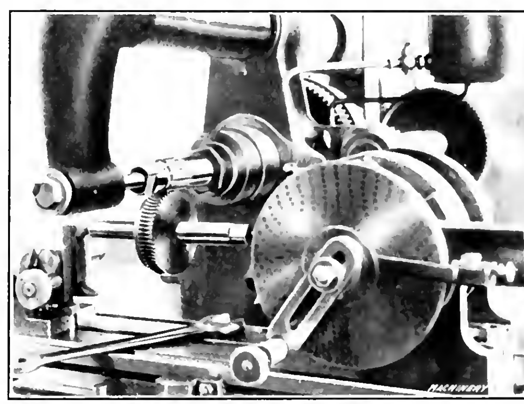


Fig. 35. The Finished Worm Gear.

obtain this they are formed by a cutting tool termed a "hob," and the operation is called "hobbing." If the hob is allowed to space the teeth without previous "gashing" it will cut a larger number of teeth than is desired upon the given cir-

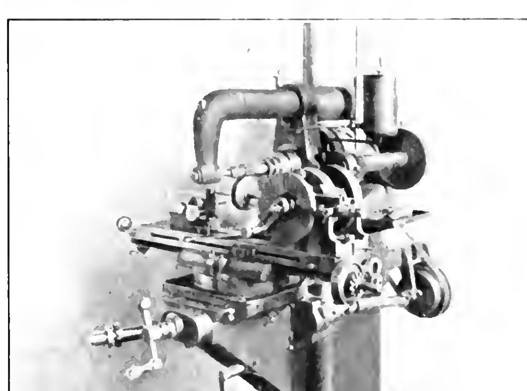


Fig. 36. Milling Machine Set Up for Hobbing

cumference. Gashing corrects this and can be done by using any cutter that will leave enough stock upon the sides of the teeth to permit finishing by the hob. The gashing cutter may be set central, as illustrated in Figs. 31 and 32. Gashing after the cutter is properly set is a question of indexing the required number of spaces and of feeding the work vertically against the cutter to give the allowed depth. The worm gear being a portion of the back section of a nut, its teeth will have a *left-handed* angularity if the worm is *right-handed*. The work table should be swiveled to give this when the blank is gashed and afterward set to zero when hobbing the teeth. After the spaces have all been indexed as in Fig. 33, the dog is removed from the mandrel and the hob placed in position, as shown in Fig. 34. In this position, and mounted as shown, the hob forms up the teeth and rotates the blank. The feed is vertical as for gashing, and to such a depth as necessary to give the required distance "center to center" of worm and gear. The finished job is shown in Fig. 35, and a general view of the machine in Fig. 36.

* * *

CHOOSING AN EMPLOYER

CON WISE.

When we used to go to Sunday school we all made resolutions prompted by what we heard there, that when we went to work for a living we would be the first ones down in the morning and the last ones home at night and that our diligence would be so noticeable that our employer would shortly call us into the office and pat us on the head and say, "Johnny, my boy, you are too valuable a man to be taking down shutters, come in and run my business and marry my daughter." And yet most of us are still working for so much every Saturday night. Now since we are all diligent in business and all know at least as much about it as the boss and none of us have any objections to the daughter, there must be something at fault besides ourselves. The least particle of logic shows that this is the employer himself. The trouble is that we are too hasty in selecting our employers. And a moment's reflection will show how important it is that we should be careful. On the average each employer hires say 50 hands. If one fails to follow his Sunday school teaching it is only a percentage of loss on 2 per cent of his force. If one of his hands finds that the head of the firm is of an uncongenial nature and quits he loses 100 per cent of his job.

Ten or fifteen years ago I heard a well-known engineer in the course of an address to a graduating class of a technical school advise them to take the first job that came along. Two or three years later I called at his shop to see his superintendent. I was referred to his home where I spent a most enjoyable half hour sitting on packing boxes with the ex-superintendent and got a side light on his former employer which seemed to explain the latter's remarks to the graduating class. It seems that he never kept a superintendent over two years and a good many less than one even though he was willing to pay good money. He evidently thought that all men traveled from one job to another so fast that a few false steps would do no harm. This man was like a lot of others, so good an engineer of materials that he had no time to consider his men in any other light than as so much additional material to be hewed or bent this way or that as his whims changed. Almost all the great successes in manufacture have had somewhere near the top some man whose knowledge of engineering may have been limited but whose ability to get the best out of subordinates was marked.

If a man wants his life to be worth living he must labor at such work and under such conditions that he can enjoy it. If he has to get all his pleasure outside of working hours it costs too much and keeps him up too late. If the work itself is congenial it is not enough. The atmosphere must be congenial too. If you can work with your employer rather than for him it is a great thing. With some employers this is impossible. They cannot conceive of a man to whom they pay wages standing on any plane of equality with them. If an employer is a large enough man so that he is likely to succeed he can afford to let his employees have all the glory that they can get. And if he is a student of human nature he knows that a share in the glory, or even a reflection of glory goes a long ways toward staving off a demand for more salary.

One way in which you can find out how good a man is to work for is to see how long his best men stay. You don't care anything about what the "floaters" say. The first man I ever worked for had an almost world-wide reputation for crankiness toward his help. But out of a crew that ranged from 30 to 50 men he had about 20 men that stayed right along anywhere from 5 to 25 years at a time. The rest were a floating population that came and went as business rose or fell. He didn't like to discharge help so about the time business dropped off he earned his reputation so fully that men were glad to leave. If a man could stand him for a year he could have a life job and do about as he pleased. Then there is the man who invariably opposes every suggestion that is made, then takes it home, dresses it up in a new form, brings it back and adopts it as his own. That kind is too narrow minded to live with. You must look out too that you don't stay too long with an employer who has disagreeable ways. There is danger of contamination. This reminds me of a family of Quakers who used to and probably still keep a large store in my native town. They were the squarest people I ever met and the softest spoken. I was acquainted with them over quite a number of years during which time they had several different men in the office. These men were of all kinds when they went there but after working a year they became as like their employer as men could become in manners and speech. It got so that it was almost impossible to tell who was answering the telephone. This is only a single instance of the influence of one man's character on another and I presume your readers will recall many more. The only trouble is that it seems as if character is more easily influenced for ill by association than for good. In one shop that I know of the proprietor addresses his foremen as Mr. So-and-So, and they in turn use the Mr. in speaking to the men. And the men in that shop will help each other if they need a hand's lift for a moment. No traveling over to the scratcher's bench to get a helper to put on a center nut. They all know that the proprietor could afford a silk hat if he wanted it and that he will, and wants to, help a man if he sees the need. These men don't snatch their pay envelopes like wild beasts after they have been there a month, and they don't swear, that is, not long abusive swears, and more than that, they are loyal to their shop and work for the shop, and not alone for themselves

Whether it is necessary to always work for successful concerns is a question. Of course no one deliberately takes a position with a concern which is known to be failing but on the other hand I don't believe that it is always wise to desert a sinking ship even if the rats do. There have been lots of rescues just at the last moment that have carried faithful employees up high on a tide of prosperity, and I never knew of a man being turned down for a good job because he worked for a concern that failed, unless he was suspected of being responsible for the failure and even then such an experience is generally understood to have an educational value. A distinctly successful concern can usually hire men for less money than one which is in the formative stage but then there is less chance for advancement in the former so it is worth less. As for a choice between working for a tactful man and a blunt one, it is largely a question of pocketbook *versus* feelings. A tactful man will pay his help quite liberally in diplomacy and hopes while the other man pays all cash, against which you can be almost sure to have to set off some loss of self esteem if not of self respect.

There is hardly a man but that can find somewhere an employer under whom he can work with comfort and pleasure, and under no other ought he to work longer than to try him out, for there are plenty of jobs for conscientious men, and this is written for no others. But even after you have secured a good employer you must keep close watch of him for he may change. His personal life is none of your affair up to a certain point but you may be sure that if you find him drinking or gambling you had best make it your personal affair to get another job. Then too an influx of relatives in his shop is a poor sign, for no matter how good an employer he may be, they will act like a bit of smoked glass held up between you and him and you might as well surrender.

DWIGHT SLATE.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Dwight Slate was born in Gill, Franklin County, Mass., May 29, 1816. At the age of 17 he entered the machine shop of Eli Horton, Stamford, Conn., as an apprentice, but so apt was he in mechanical and business sense that before the term of his apprenticeship had expired he was made a partner. Horton manufactured textile machinery and also built various machines to order, which work gave Mr. Slate very valuable experience. During the twelve years of service with the Horton shop he designed a number of new machines, among which was one for rifling gun barrels with what is known as the "gain twist."

Leaving the Horton shop in 1845 he formed a partnership with F. M. Brown, the concern being known as Slate & Brown, which located in Windsor Locks, Conn. Here a shop three stories and basement, 40 x 80 feet, was built, where they made textile machinery and fitted up many textile mills in Massachusetts and Connecticut. They also built special machines to order, and when Col. Colt received his first order from the United States government for revolvers, Slate & Brown made, on contract, barrels and cylinders for Colt's revolvers, which were used to a limited extent during the Mexican War. Mr. Slate designed a number of special machines and tools for revolver manufacture, and many of the machines of his design were afterward used in Colt's Armory, where they proved to be very valuable.

At this period the planer was a machine tool found in very few American shops and Slate & Brown installed one of the first iron planers to be used in the Connecticut Valley. With it they did much planer work for other machine manufacturers, work being sent to them from towns as far distant as New Haven. Finding their venture so successful they shortly after got out patterns and started to build planers, which were among the first of the rack and gear type in this country. One of the first of these was sold to Geo. S. Lincoln & Co., of Hartford, afterward known as the Phœnix Iron Works. Planed surfaces were then produced in most shops by chipping and filing, and when Slate & Brown announced to their workmen that they had ordered a planer for their shop, some of the men wanted to strike, as they thought it would deprive the chippers and filers of their means of livelihood.

Early in the year 1850 Mr. Slate ventured into the Southern field, going to Augusta, Ga., to install textile machinery in some of the cotton mills then being located in that vicinity. He remained in the South about five years, during part of which time he was connected with the Augusta Machine Works, which afterward built railroad cars. Shortly before the outbreak of the Civil War, he returner north and became a general contractor in Colt's Armory at Hartford, where he made important improvements in the methods of manufacture of firearms, bringing out among other inventions an improved rifling machine which is practically the same as that used in nearly all of the government armories at the present time. With the close of the war the demand for firearms of all kinds practically ceased, and leaving Colt's he became connected with the comparatively young firm of Pratt & Whitney as a designer of tools and machines. It was with the Pratt & Whitney Co. that he invented and patented the lathe taper attachment for turning tapers on the engine lathe without setting over the tailstock, which is now in general use. This patent he sold to the Pratt & Whitney Co. for $10,000, and it is conservative to state that it was one of the best investments that Pratt & Whitney Co. ever made. It was a basic patent and was never contested during its life. It gave the Pratt & Whitney lathe great advantage for toolroom work, and in many cases formed the thin edge of the wedge by which a great volume of business was afterward secured.

Early in the seventies Mr. Slate started a shop of his own in Hartford to build special machines for various purposes. About this time he got up and patented the Slate cut-off tool and a center grinder for grinding lathe centers; he also originated the type of small drilling machine known as the "sensitive drill," that is, the machine which in its original conception was so constructed that the driving belt would slip before the drill would break. The so-called sensitive drill of the present day of course is wide of the mark in this respect, but the direct application of the driving belt to a pulley on the drilling spindle, together with other features, which mark this design, have made this machine one of the most valuable of small machine tools.

In 1885 Mr. Slate incorporated his business under the present name of the Dwight Slate Machine Tool Co. to manufacture a line of light machine tools, most of which were of his own design. He is now nearly 90 years old, but is still in good health and takes great interest in current events of the day, although not engaged in active business.

* * *

In a country blacksmith shop in Altay, N. Y., there is an old foot-power metal turning lathe that was built by Amos Kendall more than half a century ago. It is very crude in construction, having wooden shears, but containing a number of features of interest, among which is the arrangement for cutting screws. The lead screw was made very short, presumably because of the difficulty and cost of cutting a long screw at that time. A split nut is provided which is connected to the carriage by a reach-rod of adjustable length so that no matter on what part of the work between the centers the thread has to be cut the reach-rod may be adjusted so as to cut the thread. Unconsciously this early mechanic used a scheme an element of which has been demonstrated to be well adapted for precision work, or, to be more exact, it has been shown to be practically impossible to make a long lead screw precise in all its parts. Even granting it could be made, it would be impossible to maintain its accuracy. A short screw, thick in proportion to its length, can be made of almost any reasonable accuracy and if a nut of equal length is used the wear will be uniform in all parts. A lathe is in use in the Straight Line Engine Works at Syracuse which has an 8-inch solid nut and an 8-inch precision screw designed by Prof. John E. Sweet. The screw is hollow and is larger than the regular lead screw, being mounted as a sleeve upon it. Provision is made for holding it fast to the lead screw and for fastening the nut to the apron. When threading piston rods (for which work it is used) the nut is so adjusted that it travels equally each side of the center of the screw, thus making the wear uniform on both sides.

* * *

It is claimed that the particles of India ink when examined under a powerful microscope are found to be moving about with immense activity, and this movement, which is characteristic of inks in general, is said to be the reason why true inks do not settle. The addition of certain salts, however, stops the rapid motion, whereupon the particles group themselves together and descend to the bottom in precipitate form.

A NAVAL GAS ENGINE.

M. JOACHIMSON.

The idea of the gas engine for marine propulsion, in connection with a gas producer, is not a new one, since its advantages for this purpose were discussed soon after the appearance of the Otto 4-cycle engine. The marine service, however, requires so many special conditions of the gas motor that it is not surprising many years elapsed before the marine gas engine became a practical machine. The disadvantage of the stationary gas engine, compared with the steam engine, is that the former is not as economical under variable load, although of superior economy at normal load. In marine work the engine generally runs under full load and in this case the gas engine operates with a heat efficiency of 26 per cent as against 15 per cent for the best steam engine—an efficiency which can only be attained in the largest sized units. A high efficiency for the gas engine, however, may be maintained, even in the smaller sizes.

In what follows is a description of a marine engine and producer developed by M. Emil Capitaine of Frankfort-on-the-Main, and an account of the methods used in overcoming some of the difficulties encountered in perfecting the apparatus. M. Capitaine employs a suction producer.

In a suction gas plant the producer takes the part corresponding to the boiler of a steam plant. The simplest producer consists of a cylindrical vessel in vertical position made of boiler plate and lined with fire brick. A mixture of air and steam is sent through a mass of red hot coal contained in this producer. The carbonic acid developed by the combustion is decomposed into carbonic oxide by passing through the upper layers of fuel. The gas so produced contains about 120 B. T. U. per cubic foot. If steam passes with the air the gas is of the following composition:

Carbonic Acid (CO_2)	6 per cent.
Carbonic Oxide (CO)	26 per cent.
Marsh Gas (CH_4)	5 per cent.
Hydrogen (H)	14 per cent.
Nitrogen (N)	53 per cent.

Fig. 1 shows the elements of a producer plant. The gases leave the producer *A* with a temperature of about 930 degrees F. and go through the evaporator *B*, where their heat is utilized to raise steam. The latter is led by a pipe under the grate of the producer through which it flows into the mass of coal and is there decomposed. After passing the evaporator the gas reaches the scrubber *C*, which vessel is filled with coke, constantly sprinkled by cold water, the non-combustible

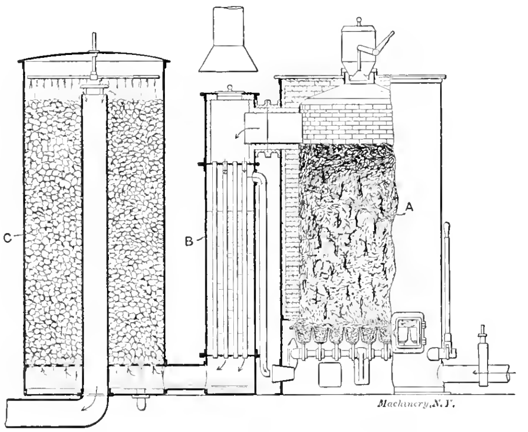


Fig. 1. General Arrangement of Suction Gas Producer.

ingredients of the gas become separated by touching the damp surface of the coke. The suction end of the gas engine is directly connected with the outlet of this scrubber, and at every stroke the engine draws a mixture of steam and air through the hot fuel bed *A*, and the hot gas developed passes the evaporator *B* and scrubber *C* to reach the suction valve of the engine. To assure a proper working of the engine a steady gas supply of uniform quality is needed. This can only be attained if the surface of the coal presented to the passing steam, air or gas remains constantly of equal size. If anthracite or coke is used this condition is easily met, but with soft coal it is a problem hard to solve; as the contents of the producer clinker to a solid mass and either inhibit the flow of gas or else fissures appear and the air passes through them without decomposition. In both cases the result is a very poor gas. Anthracite requires per horsepower about 400 square inches of surface, which is represented in 160 cubic inches weighing 5.5 pounds. Coke requires a little more, but if soft coal is used the surface varies, growing smaller as the fuel gets hotter.

A producer designed for 1,000 horsepower will, if used with soft coal, supply gas for only 200 to 300 horsepower when

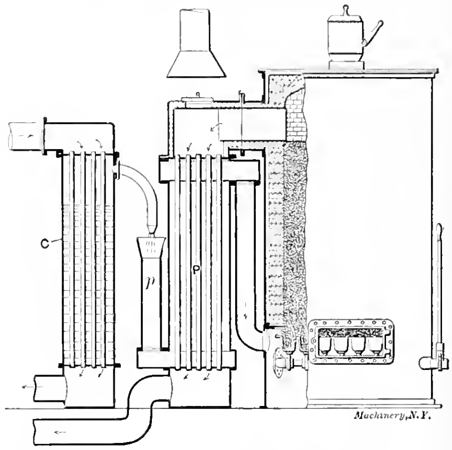


Fig. 2. Producer for Utilizing Heat of Exhaust from Engine.

the coal becomes incandescent. For this reason producers using ordinary coal must be built very high to prevent the air passing through the open fissures without coming in intimate contact with the hot fuel. A producer of 2,500 horsepower using soft coal would be 10 feet inside diameter with a depth of coal of 10 feet; and with outside dimensions of 14 feet high and 12 feet diameter. The weight (as this must be considered like the water in a boiler) is 40 tons, against 200 to 250 tons for the boiler of a tug or a yacht or 35 to 40 tons for a water tube boiler of a cruiser. If harder coal is used, which is less liable to clinker, the dimensions may be considerably reduced, the generator in this case being only 10 feet high instead of 14 feet.

The following comparative figures are of interest:

The space for Scotch marine boilers is about 14 cubic feet per horsepower and the weight about 200 pounds per horsepower.

The space required for water tube boilers is about 5.3 cubic feet and the weight about 51 pounds per horsepower.

The space required for a gas producer is 1.75 cubic feet and the weight 51 pounds per horsepower.

These figures do not include the water purifying apparatus and the steam generator for gas. The weight and space for the water, however, may be compared with the weight and space for the condenser plant of the steam engine, which is also not included in the above figures.

The purity of the gas is of the highest importance for the proper working of the engine. Gas which contains tar is injurious for the engine, as coal tar collects in the cylinder, covers the piston and clogs up the valves, and finally, heated by the explosion, it causes pre-ignition. For this reason it is desirable to design these motors in such a way that they may easily be cleaned. To avoid the tar in the gas as much as possible producers were designed with two layers of combustible, one above the other. The air enters from above, with steam from below, and the gas is taken off at the center, the hottest part of the producer, without passing any new and tar supplying coal. For marine service this style generator would be too high and a modified form was designed with double furnaces, side by side, and with the coal fed in between them automatically by a screw conveyor or stoker.

To increase the efficiency of the producer the gas engine exhaust was made to pass through the evaporator *C*, Fig. 2, and the steam so generated was mixed with air at *p* and

passed through a superheater P, the pipes of which were heated by the gases coming from the generator. The air and steam mixture enters the fuel bed highly superheated and by this system 90-95 per cent of the heat contained in the fuel may be realized in the gas. The amount of water needed for evaporation is about ½ pound per horsepower for a coal consumption of ¾ pound, but it is more favorable to have a slight excess of water. For salt water the evaporator mentioned before would be impractical on account of incrustation, and a special purifier has to be provided. The one shown in Fig. 4 is designed in such a way that the concentration of sea water cannot exceed a certain limit, since the water flows continuously through the purifier. The fresh water enters at a, passes upwards through the coil t, whereupon it enters the condenser and is evaporated to contain 3 to 4 per cent of salt. This saturated hot water flows into the space s, heating the coil and the fresh water in the same, and escapes through the discharge z. With a sufficient heating surface the heat losses in this purifier are inconsiderable and it needs cleaning in long intervals only.

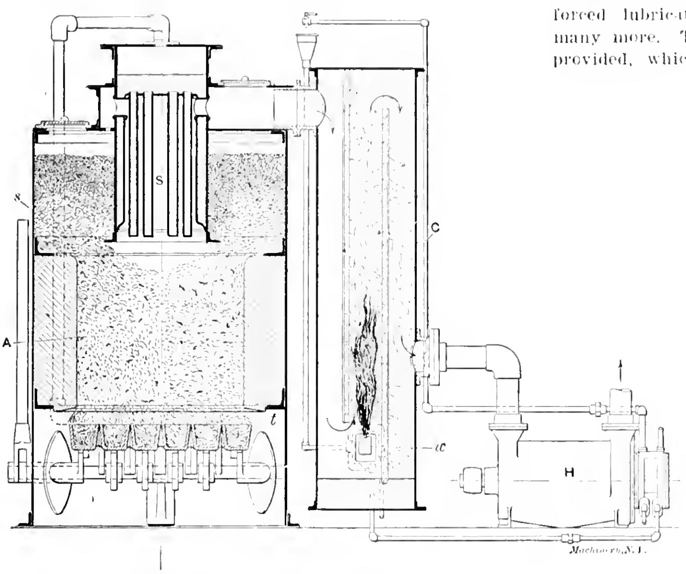


Fig. 3. The Producer used by M. Capitaine for his Marine Engine.

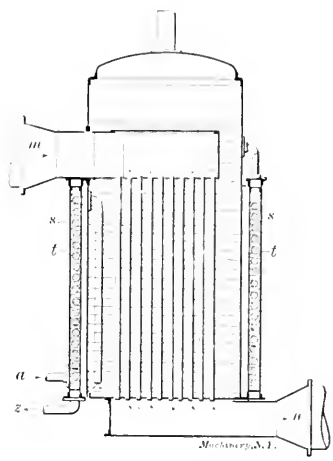


Fig. 4. Modified Evaporator for use with Salt Water

One of the greatest difficulties of a producer for marine purposes for tugs, yachts, etc., consists in the falling off of temperature in the generator, when the engine either stops or works at half power. At such times the temperature in the producer drops more or less, which in turn reduces the heating value of the gas so much that the engine will not start up immediately at full power. The larger the dimensions of the producer the longer can a constant temperature be maintained; but in generators up to 150 horsepower the temperature drops quite rapidly. For marine propulsion the gas engine would be absolutely of no use if this problem were not solved, and it has been accomplished in different ways.

The design of the new Capitaine producer and gas engine is illustrated in Figs. 3 and 5. The gases produced in the generator escape from its hottest part and heat the pipes of the evaporator S; and as they cannot come in contact with fresh coal, they carry but little tar. They now pass to the cleaner and cooler C, into which water is sprayed at w. The close contact with the large surface of water washes them thoroughly. The centrifugal dryer H, which has a circumferential speed of 300 feet per second, serves the double purpose of drying the gas-water mixture and of removing all solid particles from it. It delivers a very pure gas to the engine, which is directly connected to the dryer. This system of cleaning the gas requires an exceedingly small space and is therefore specially suited for marine purposes.

The fuel used is anthracite or coke and in its fresh state surrounds the evaporator S wherefrom it falls into the furnace A through an annular opening. The grate also is of special design, the bars being of channel section containing ashes inside and cooled on the outside by the air led into the generator.

The Capitaine gas engine used with this producer is a 4-cycle, multi-cylinder engine with frame of structural shapes to reduce the weight. The different parts of each valve system can be cleaned entirely independently of the others.

Many other details are specially designed for marine service as the automatic timing of ignition with varying speed, forced lubrication, automatic starting of compression and many more. To start the engine a small gasoline motor is provided, which however works a few minutes only every day. The boats are reversed by adjustable propeller blades, up to 100 horsepower. For larger boats this is done by a reversing gear arrangement.

The consumption of coal per horsepower hour is stated to be one pound for engines up to 30 horsepower, 0.88 pound for an engine of 50 horsepower, and 0.82 pound for an engine of 100 horsepower.

For purposes of comparison tests were made on November 8th, 1904, upon *Gastug* and the steamer *Elfriede* before the Dock Department at Hamburg.

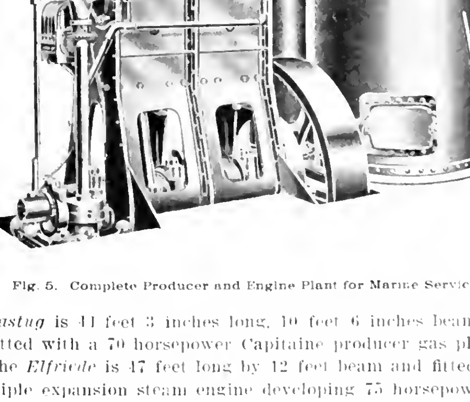


Fig. 5. Complete Producer and Engine Plant for Marine Service

Gastug is 41 feet 3 inches long, 10 feet 6 inches beam, and is fitted with a 70 horsepower Capitaine producer gas plant.

The *Elfriede* is 47 feet long by 12 feet beam and fitted with a triple expansion steam engine developing 75 horsepower.

At the towing meter *Gastug* attained a maximum pull of 2,110 pounds and the *Elfriede* of 2,020 pounds.

A run was made by these two boats during very stormy weather at a maintained speed of 8.5 knots. The consumption of fuel was as follows:

For 10 hours *Gastug* 530 pounds German anthracite; and *Elfriede* 1820 pounds steam coal. While these results are exceptionally satisfactory for boats of small size, the inventor who tries to conquer the field of marine propulsion for gas engines as applied to the largest ships has much greater problems to contend with. In the larger units necessary for ships of great size the gas engine in its present form appears to be wholly impracticable. Steady, quiet motion, with variable speed and almost instant reverse are the requisites for such engines, and it is safe to say that a 4-cycle engine of much more than 1,000 horsepower could not be designed to meet these requirements, since the mass of the moving parts and the pressures of crankpins and journals would be enormously

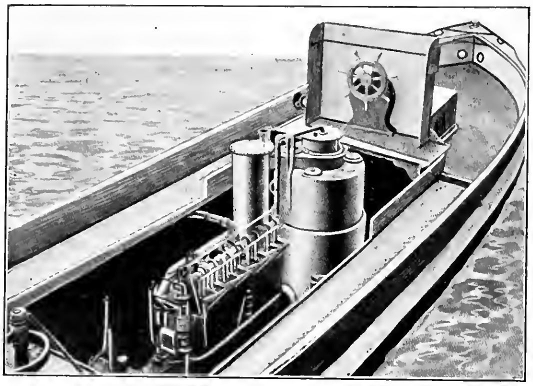


Fig. 6. Producer and Engine Installed in Boat.

high. The weight of the reciprocating parts would prevent effective balancing and the piston speed should be greater than feasible in such sizes to prevent the gases from cooling off before their heat could be transmitted into work. An engine of 1,000 horsepower has meanwhile been built by Messrs. Wm. Beardmore & Co., Glasgow, and is being installed in the former steamer *Earl*, whose old engines were removed.

M. Capitaine has experimented with a system similar in principle to the so-called free-piston engine of historic fame, which has now become entirely obsolete in stationary practice. He proposes the construction shown in Fig. 7 where there are two pistons running against each other, connected to swinging levers *D* and these levers connected to the oscillating disc *F* which runs freely on the engine shaft during the outstroke of the pistons, but is clutched to it in the

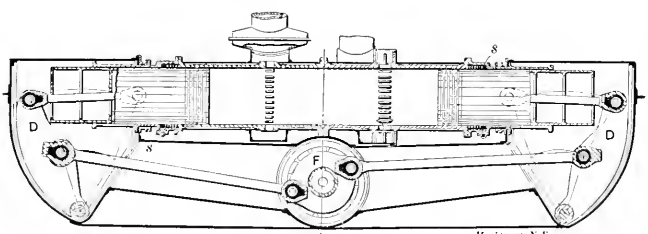


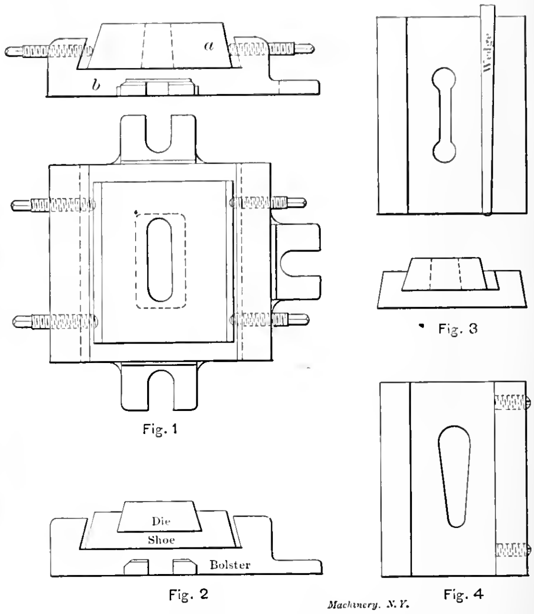
Fig. 7. Marine Engine Design Proposed by M. Capitaine.

return stroke. The cylinders and all moving parts are to be built in an air-tight chamber, the pressure in which is kept at about 45 pounds. The gas inlet and outlet is effected by slotted holes as generally used on 2-cycle engines. It is believed that the perfect balancing of this engine will make high piston speeds possible and the weight of the reciprocating parts can therefore be reduced and more power for a given weight of engine can be obtained. It would go beyond the limit of this narrative to describe the details of this engine until they are proved a practical success. So far they have only proved the correctness of theory in a 20-horsepower model engine.

PUNCH AND DIE WORK.—1.

E. R. MARKHAM.

Under the head of punch and die work is generally included all the various tools used in blanking pieces from the commercial stock; bending stock to shape; drawing out articles from sheet stock; and all the different operations performed with punching, drawing and forming presses. The most common form of tools to be considered is the dies used for blanking articles from sheet stock, called blanking dies.



Various Methods of Holding Dies.

A set of blanking dies consists of a male die, or punch, as it is generally termed, and a female die, or die block. These terms are generally abbreviated and the set is called a punch and die.

Blanking dies are generally considered as belonging to one of three classes: First, plain (or simple) dies; second, gang dies; and third, compound dies.

When punches and dies are used in a "punch" press, and are to constitute a part of the regular equipment of the shop they are held in suitable permanent fixtures. Dies are held in position on the bed of the press by means of a holdfast, the name of which differs in different shops. Some of the more common names are chair, chuck, bolster, and die holder. Dies large enough to warrant it are clamped to the bed of the press, thus doing away with the necessity for holders. Dies are fastened in place in the die holder by several methods, the most common of which is by means of screws, as shown in Fig. 1, in which *a* is the die and *b* the holder. Having screws on both sides it is an easy matter to adjust the die, loosening the screws on one side and forcing it over by those on the opposite side

When the die is small, it is generally held in a shoe, as shown in Fig. 2. The manner of fastening the shoe depends on the preference of the designer. In some shops the shoe is dovetailed as shown, the angle being 10 degrees to 15 degrees from a right angle; or, in other words, it is 80 degrees to 75 degrees with the bottom. The slot is made somewhat tapering. The die is given a corresponding taper and angle on its sides and, to fasten in position, it is driven securely in place. The amount of taper given the slot in the shoe must not be great or the die will jar loose when in use. A taper of one-half inch per foot of length answers nicely.

In other shops the shoe is made with a groove, as described above, only it is from ¼ to ⅜-inch wider than the dies, which are held in place by means of a taper key or wedge, as shown in Fig. 3. When making this form it is

necessary to make the dies of equal width on their ends. This method does not entail so great a degree of accuracy when machining the die block.

A third method consists in making a shoe having the back of slot planed at the angle mentioned, while the front wall is made square with the bottom, the die being held with set-screws, as shown in Fig. 4. If this form is used, care must be exercised when laying out screw holes that they do not come in line with the screws in the bolster when the shoe is in its proper place; and, again, the screws must not press on any portion of the die immediately in line with the opening,

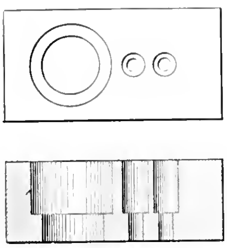


Fig. 5

A Case where a Bushed Die is best Used.

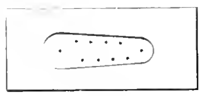


Fig. 6

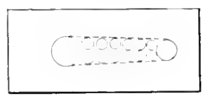


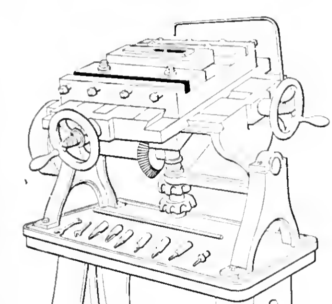
Fig. 7

Machinery, N.Y.

Working Out the Stock in a Solid Die.

or it will be closed somewhat when pressure is applied to the screws. Fig. 4 shows the screws pressing on the solid portion of the die.

Dies which are fastened in bolsters without using a shoe must have their sides machined at an angle, as in Fig. 1, to prevent them lifting from the strain incident to removing the punch when it has pierced the stock. The angle should be from 10 degrees to 15 degrees, some mechanics claiming best results with 20 degrees. The latter, however, seems greater than there is any necessity for on ordinary work.



Machinery, N.Y.

Fig. 8. A Die Milling Machine.

For most work the stock used in making punches and dies should be a good quality of tool steel. A die that has cost from 5 dollars to 100 dollars for labor is as liable to crack when hardening as though the same steel had been made into any other form of tool; and in fact its shape and irregular thickness of stock at various points, together with numerous sharp corners that are liable to be present, make a tool that requires extreme care in handling when hardening. Now a good grade of tool steel, free from harmful impurities, is less liable to crack than an inferior grade, and the slight difference in cost is offset many times by the cost of labor in its construction.

The writer would not be understood by the above as necessarily advocating the use of a *high-priced* steel for this class of work; simply a *good* quality of steel, low in percentage of those impurities which cause trouble when the steel is hardened. When we speak of good, reliable steels, we do not necessarily mean high-priced steel.

The writer was connected with a manufacturing concern at one time where from six to ten dies were made each day; all of them being made of a good grade of open-hearth machinery steel that cost less than 3 cents per pound. The steel contained 60 points carbon (0.6 per cent).

The reason for using this grade of steel was that we had plenty of it, as it was bought in the billet many tons at a time for another purpose, and in cutting up and forging quantities of the stock were left as scrap which could not be utilized for anything else. Most of the work done was job work and there was no surety of a second order. The dies were generally in good condition when the order was completed, and in many cases answered for many subsequent orders. It was necessary, however, in order to get best results, to harden them by the pack hardening process, which entirely eliminated the possibility of their cracking and gave them a durability far in excess of many dies made from tool steel hardened by the ordinary method. On general principles, however, I should not advocate the use of any but a good grade of tool steel for this work. If those in charge have had an experience that enables them to discriminate, they will be able to judge when a low-grade steel like the one mentioned will answer.

If best results are desired when hardening, the steel should be annealed after the outer surface of the piece has been removed and the opening blocked out somewhere near to shape.

In all shop operations true economy should always be practiced and many times this may be done by a saving of tool steel. If a die is like Fig. 5, a saving may be effected by making the body of cast iron and inserting disks of tool steel; and if we wish at any time to make a new die, we simply make the disks, and if ordinary care is taken the holes will be concentric and consequently the proper distance apart, so there will be no necessity of altering the location of the punches, as might be the case if a die made of a solid piece was hardened.

Fig. 9

Fig. 10

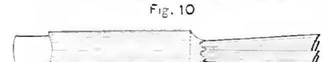


Fig. 11

Machinery, N.Y.

Tools used in Die Making by Machinery.

When a number of dies are to be made to fit the same holder, they may be planed to size in the bar and then cut apart by means of the cold-sawing machine. It will be necessary to plane the finish side of dies that must fit a shoe of the style shown in Fig. 2 as one end must be wider than the other. This may be effected very readily by having a strip of cast iron planed to the proper taper to place the die on when planing or milling.

The face of the die must be smooth in order that the outline traced on it may closely correspond to the templet. If the surface is a succession of ridges, the scriber will not closely follow the edges of the pattern, and the figure traced will be larger than desired.

Most up-to-date shops keep a record of the cost of every tool made, as well as any peculiarities of the finished tool. This necessarily is a record of each man's work, its cost and condition. The toolmaker who is desirous of advancement should keep the cost of articles he makes as low as is consistent with good work, and the quality as high as is consistent with reasonable cost of an article of the kind.

After the face has been made smooth by planing, grinding or filing, the surface may be coated with the blue vitrol solution, or it may be heated until it assumes a distinct straw or blue color, and the outline of the piece to be punched laid out.

If the die is what is known as a solid die, that is, made from one piece of stock, it may be laid off and prick-punched as in Fig. 6, after which holes may be drilled, leaving the face of the die as in Fig. 7, after which the core may be removed. When drilling for the opening, first drill any portions which are to be left circular or semi-circular in shape. These are then reamed from the opposite side with a taper reamer that will give the desired amount of clearance.

When drilling to remove the core mentioned, some toolmakers use drills of a size that break into the next hole. After drilling way around the core drops out of its own accord. If this method is adopted, best results follow the use of the straightway drill, Fig. 9. Others drill with drills of the size of the pilot of a counterbore and after drilling all the

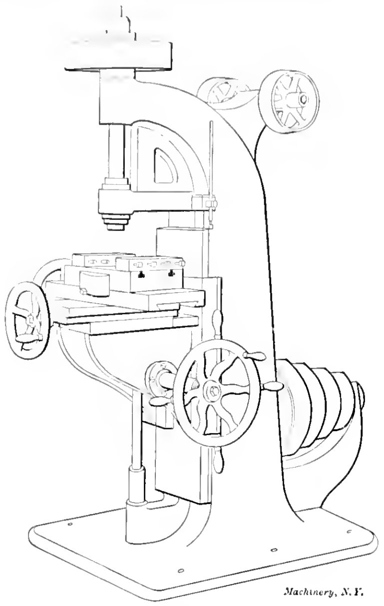


Fig. 12. A Die Sinking Machine.

holes the counterbore is run through. Of course, it is understood that in laying off for the holes they are located so the counterbore breaks into the next hole.

A third method consists of laying off and drilling holes so there is a little stock between the holes after drilling, which is broken out by means of a drift driven in from each side until the cuts meet. In this way the stock is cut away and the core removed.

After taking out the core the die may be placed in a die milling machine, or a die sinking machine and by the use of

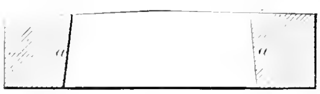


Fig. 13

Fig. 14

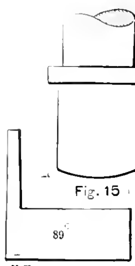


Fig. 15

Fig. 16

Figs. 13 and 14 Correct and Incorrect Relief. Fig. 15. Punch Crowned for Stiff Stock. Fig. 16. Templet for Relief.

a tapered milling cutter the stock may be removed and the desired angle of clearance given the walls of the hole. The angle of clearance necessary for best results cannot be arbitrarily stated, but varies according to the character of the work to be done with the die. In the absence of either of the milling machines mentioned, a universal or a hand miller may be used. There are various slotting devices which may be attached to universal milling machines which are used advantageously on work of this character. During the past few years several vertical filing machines have been placed on the market which are recommended highly for the purpose of working the openings of dies to shape.

The writer is not in a position to speak positively regarding these machines; he was at one time with a concern employing quite a number of skillful die makers. One of these machines was installed and for some reason failed to give as good results as claimed for it. In fact, a die could be filed out by hand in less time than by machine and the hand work was fully as satisfactory. However, had the machine been introduced into a shop where less skilled labor was employed to do the same class of work, the results might have been in favor of the machine. The men employed in the die room mentioned were all very proficient in that particular branch of work, and I realize that the machine was up against a hard proposition, so I would not be understood as condemning it, but simply give our experience with it. If a die milling machine, Fig. 8, is used, the form of taper milling cutter shown in Fig. 10 is employed. As the milling cutter is driven by a spindle beneath the die, the cutting portion extending up through the opening, with the face of die uppermost, the small part of the cutting portion should be at the end of the cutter.

If a die-sinking machine, Fig. 12, is used, a cutter like Fig. 11 is used. After working the opening to shape and size as nearly as possible with the milling cutter, it may be finished by filing. According to the writer's experience there never was a time when skillful die makers were in demand more than at the present time; the fact that so few apprentices are taught the use of hand-operated tools to an extent that makes them skillful in their use creates a condition that is favorable to those who have been fortunate enough to have acquired skill in the use of the chisel and file. Not that their use is to be advocated where it can be dispensed with, but there is, and always will be, a demand for men skilled in their use.

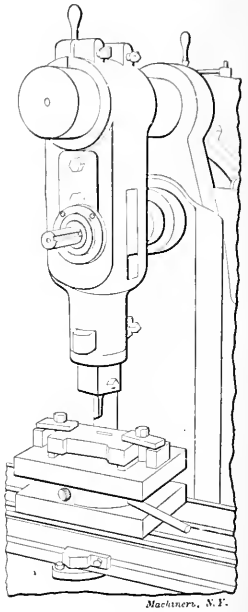


Fig. 17. Die Slotting Attachment for Milling Machine.

When finishing the opening to shape and size it is necessary to get the desired clearance and to have the walls of the opening straight, as at *a a* in Fig. 13, rather than rounding as represented at *a a* in Fig. 14.

The amount of clearance differs for various work and ranges from one-quarter to three degrees. The greater amount is seldom given unless it is necesssary that the blank fall from the die each time one is punched. Another instance where it is desirable to give excessive clearance is where a punch with a crowning face, as in Fig. 15, is used for punching stiff stock.

When a milling machine with a slotting attachment, Fig. 17, is used, sharp corners may be cut to the line, as may certain irregular surfaces which could not be shaped with milling cutters. Of course, it would be necessary to have cutting tools of the proper shape to machine the forms men-

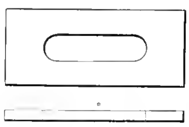


Fig. 18. A Product for which the Punch should have a Shear.

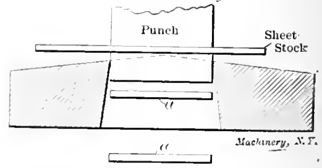


Fig. 19. A Case where the Shear should be on the Die.

tioned, the advisability of making which would depend on whether it would be cheaper to make the necessary tools and to do the machining, or file to the desired shape.

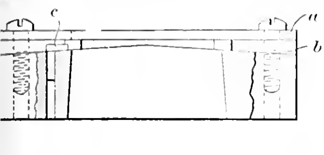
A fixture known as a die shaper, whose action resembles the slotting device described above, is made to attach to a milling machine and works the same as the other attachment.

In order to gage the angle of clearance it is advisable to have angle gages. Several of these may be made and kept in

he tool chest and should be of the more common angles ised. They may be of the form shown in Fig. 16, with the ngle stamped on the heavier portion.

The cutting faces of dies are given *shear* for the same reaon that the teeth of milling machine cutters are made piraling. The shear makes it possible to cut the blank from he sheet with less expenditure of power; it also reduces the train on the die and punch. While it is customary to shear he face of the die when possible, there are instances when t is advisable to leave the face of the die flat and shear the unch.

The *shear* is given the *punch* when the stock around the iole is the desired product and the stock removed is scrap, as in Fig. 18. The face of die is sheared when the portion pressed through the die is the product, as at *a a* in Fig. 19, which also illustrates the shear of the die.



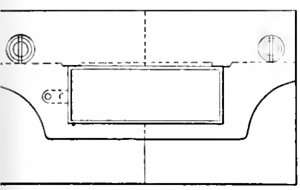


Fig. 20. Example of a Stripping Plate.

The amount of shear necessary to give a die to obtain best results depends a great deal on the thickness of the stock to be punched, and also on the length of the piece to be removed, and on the power of the press.

Shear of a die usually commences at the center and extends oward each end, as in Fig. 19, the punch being left flat on its ace. When the punch descends, the cut commences at the iighest point of the die, which is in the center, and continues oward each end. The portion at the center will have been emoved from the stock before the cut has progressed very 'ar toward the ends, and in this manner the cut is disributed over the length of the piece, reducing the strain on he press and tools.

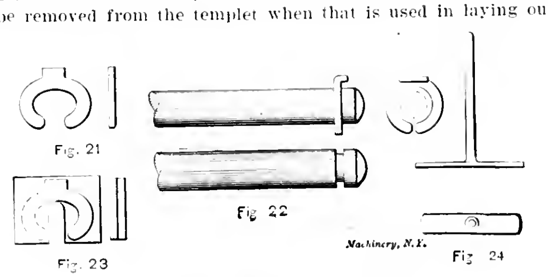
The diemaker, if he works to drawings furnished him by he draftsman, makes the thickness of die and length of unch to correspond with dimensions. However, it is cusomary in shops where few dies are made and no draftsman is mployed, to give the diemaker or toolmaker an idea of the hape and dimensions wanted, or possibly a templet, and he s obliged to go ahead and "work out his own solution." In such cases the workman must first find the dimensions of he press to be used, the distance from the bed to the ram, the ength of stroke of the ram, the amount the ram may be adusted, the thickness of the bolster, and particulars about any hoes that are to be used. These things should be carefully et down and kept where the workman may have access to hem at any time. If there are several presses, each should e marked and the dimensions of each carefully recorded, according to the work of the individual machine. If this precaution is followed and the dimensions taken into consideraion when machining the die and punch, there need be none of the trouble sometimes experienced, such as a die too thick or a punch too long, or the reverse, for the press in which hey are to be used. To a man working in a shop where due attention is given to every detail, such examples of carelessness may seem "far fetched"; but nevertheless, these things do happen.

When articles are punched from sheet stock or in fact from any stock where scrap is around the punch, the stock will be carried upward when the punch ascends, unless some device is furnished to prevent its doing so. Fig. 20 shows an arrangement (*a*) called a stripper, or stripping plate, the opening in this being a trifle larger than the punch. The stripper plate must be securely fastened to the die, or the die holder, and must be stiff enough to prevent its springing when in use. Between the stripper and the die (at *b*) is a guide against which the stock being operated on rests and it determines the amount of scrap at the back edge of the sheet. The stripper is made of a thickness that insures the space between the die and stripper being somewhat greater than the thickness of the stock used; in fact the space must be sufficient to allow the stock to move along easily even when the surface is made somewhat irregular by the operation of punching. At *c* is a guide pin or stop against which the stock is placed to determine the endwise setting.

When dies are made for producing pieces that must be of a given size and shape it is necessary to have a piece of the same shape and size to work to; this is called a templet. At times it requires a considerable degree of skill to make a templet that will answer for the work in hand. The writer recalls an instance when as a young toolmaker he was given the job of making a templet of the design shown in Fig. 21. After blanking and turning the ear at the top, the piece was to be closed on a groove in an axle, as shown in Fig. 22. After closing, the outside of the washer was supposed to run about true. The die was made to the templet and it was found less difficult to make the die than the templet. In this instance it was necessary to make two pieces of the desired shape exactly alike, one of which was closed on the model axle and tested. The points that were not right were located on the one that had not been closed up. Then others were laid out from it, due allowance being made for the imperfections of the first. When making, two pieces of stock were placed together and one half was worked to the laying out lines as in Fig. 23. After the other half had been blocked out somewhere near the line the pieces were reversed and each half that had been blocked out was finished to the finished half, as shown. In this way the ends were exactly alike and the two being machined, or filed together, were of course, alike. When one was turned or closed on the axle and was found correct the other answered for the templet to be used in laying out the die and afterward to fit the opening, too.

While the example related was comparatively simple, it did not appear altogether simple to one not accustomed to that class of work, and it serves to illustrate the idea brought out.

In order that templets may be easily handled it is customary to attach some form of handle to them, which is sometimes done by drilling and tapping a hole in the templet, and cutting a short thread on a piece of wire which is screwed into the tapped hole. Another common method is to attach a piece of wire by means of a drop of solder, as shown in Fig. 24. This method is open to the objection that the wire must be removed from the templet when that is used in laying out



Templets and Means for Holding them.

the punch, as it is necessary when the templet differs in shape on two edges to lay opposite sides of the templet against punch and die. This will be considered again under punches.

* * *

A newspaper item says that James Lick, the San Francisco millionaire who founded the observatory bearing his name, was very particular about orders being obeyed strictly. It is alleged that whenever he took anyone into his service on his estate the applicant was asked to plant a tree upside down, the roots in the air and the branches in the ground. If the unfortunate made any protest he was sent away at once for the test was one to show whether he would obey orders strictly without questioning them. The foregoing no doubt is an example of the tommyrot about successful men that certain writers try to impress on the younger generation as good instruction. As a matter of fact a man who would not question such a foolish or crazy procedure as this would not be worth his salt, unless he was "onto the game." The value of an employee is determined not only by his willingness to obey orders, but by his ability to execute them with some intelligence as well, and not as a mere automaton.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1906.

PAID CIRCULATION FOR JUNE, 1906,—22,295 COPIES.

MACHINERY is published in four editions. The practical work of the shop, is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

EDITORIAL CHANGE.

Lester G. French, for nine years editor of MACHINERY, has resigned with a view to taking up a line of work of his own. His plans include the publication of a series of technical books, the first of which will be a treatise on steam turbines, which he has had in preparation for several months. His address for the present will be Brattleboro, Vt.

The people who know Mr. French best and appreciate him most highly are those who have worked with him daily in this office during the past nine years; but outside of this circle is a far wider one comprising those who know him in his editorial capacity and who will join us in our regrets at his departure and in wishing him good luck in the future.

Fred E. Rogers, for nearly eight years associate editor of MACHINERY, will continue in Mr. French's position.

* * *

ALCOHOL IN THE ARTS.

The bill giving manufacturers and the general public denaturized alcohol for industrial purposes, entirely free of tax, and upon which comment will be found in another part of the Engineering Edition, is a broad and liberal measure. It proposes that domestic alcohol may be withdrawn from bond, without the payment of an internal revenue tax, for use in the arts and industries and for fuel, light and power, provided the alcohol shall have been mixed, in the presence and under the direction of an authorized government officer, with methyl alcohol or other denaturizing material. It provides, however, that this latter may be of a character suited to the use for which the alcohol is withdrawn, so that no one requiring alcohol in the manufacture of his products will be hampered or restricted in any way by the requirements of the denaturizing process. The alcohol is to be treated in bonded warehouses especially designated for denaturizing purposes only.

Although a severe penalty is imposed for attempting to recover, by distillation or otherwise, pure alcohol from denaturized alcohol, there is a provision whereby alcohol pressed out or evaporated from products during their manufacture may be recovered and restored to a condition suitable for use again in the manufacturing process.

While there is a probability that this measure will give a great impetus to the manufacture of many lines of products, the particular use that the readers of MACHINERY will be interested in is in connection with the internal combustion engine. The aspect is a foreboding one for the small steam engine, which has already been largely replaced by the gasoline and gas engine and may have to further succumb under the pressure of the alcohol motor.

* * *

In an article this month by our contributor, Mr. Fairfield, is a series of views of the successive operations required for making a simple machine part. These views probably come as near to the moving picture method of representing progressive motion as is feasible under the conditions. None of the operations shown is unusual or unfamiliar to most of our readers. Apart from the attractiveness that illustrations of progressive motion naturally have, however, these views, though commonplace, represent good shop practice and are well worth careful study. They will at least serve to impress the fact that a large number of steps or elementary operations are required in making even so simple a machine part as a wormwheel. Thirty-six illustrations were necessary to give a fair idea of these operations; and it is only by a detailed study of each individual one, in the manufacture of wormgears or of any other part of a machine, that the cost of machine work can be reduced to its lowest limit. The most successful attempts at cost reduction have been made through a study of the time required and the methods to be used for the most minute subdivisions of manufacturing processes, even to the extent of using a stop watch for determining such elements as the time required to clamp a tool in the tool post or to release the spindle of a tail stock. Having data upon such elements, the skillful director of machine work can, by adding one element to another, build up his estimate on a scientific basis; whereas if the estimate is based upon the aggregate time required to perform several steps in an operation upon a piece, the results cannot be arrived at with anything like the same degree of certainty.

* * *

FIRE PROTECTION.

The new shops of the Western Electric Co., Hawthorne, Ill., are models in design and arrangement and the whole plant indicates extended and careful preliminary planning. Not the least feature of interest is the unusually complete provision against loss from fire. There is an ample water supply, the grounds and buildings are protected by hydrants and sprinklers, and all the usual apparatus for fire fighting has been provided. Beyond this, however, precautions have been taken to have a thoroughly trained and competent force of firemen ready to render instant service and a special watchman makes it his duty to inspect the various departments and operations in order to detect possible sources of conflagration.

Manufacturers are rapidly coming to take a more rational view of fire protection as related to insurance questions. Instead of paying insurance companies exorbitant sums for the protection of fire traps, they are now learning to provide the real protection themselves and pay the insurance company a much smaller premium as an extra safeguard against what in their case is the remote possibility of destruction by fire through some very unusual cause. It was recently stated in the columns of *Insurance Engineering* that during a period of 44 years the stock fire insurance companies of the United States have received premiums aggregating over $3,500,000,000. We should be a thriftless and short-sighted nation if we were to allow such a condition to exist indefinitely as is represented by this enormous amount, paid to companies for protection, when that protection could have been provided *in the main* by the property owners themselves for a sum insignificant compared with that represented by the above. This is, in fact, the basis on which the mutual factory fire companies are organized.

* * *

An appreciative reader says of the shop receipts and formulas: "Your receipt column in MACHINERY is a grand good thing and I hope it will continue until everything a white man can make use of is there." The column will continue as long as its readers are enough interested to send us their tried and true recipes for publication.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Much difficulty is generally experienced in getting paint to adhere firmly to galvanized iron, and various experiments are resorted to to overcome the trouble. The government has adopted a mode of procedure that seems to be satisfactory. Their specifications compel the use of vinegar for washing the surface preparatory to painting. This roughens or corrodes the surface, and gives the paint better adhesion.—*Railway Master Mechanic.*

A rock crusher is being built by the Power and Mining Machinery Co., Cudahy, Wis., which, because of its great size and capacity, is to be classed with the largest, and perhaps as the largest of its kind. The crusher is to weigh 100 tons and is expected to eat its own weight in rock every 8 4/7 minutes, having a capacity for crushing 700 tons of rock an hour. The crusher will be installed at Little Falls, New York, and the crushed stone will be used for ballast, railroad and concrete work. Here, as in successful manufacturing industries of to-day, the by-products are to be utilized. All of the dust or fine material accruing from the crushing of the stone is to be used for making cement bricks.

A good method of estimating the horsepower that can be transmitted by a wire rope drive, says a writer in *Ice and Refrigeration* is to multiply the speed of the rope in feet per minute by three times the span in feet and multiply this result by the weight of the rope in pounds per foot; this product divided by 33,000 gives a conservative figure for the average horsepower transmitted by wire rope drive. Expressed as a formula it would be as follows:

$$HP = \frac{3SVW}{33{,}000}, \text{ in which}$$

V = speed of rope in feet per minute;
S = span, in feet;
W = weight of rope, in pounds per foot.

The position occupied by the mechanical stoker is clearly outlined in a bulletin of the Iowa State College Engineering Experiment Station, the bulletin being notes on power generation in Iowa. In regard to tests of mechanical stokers the report says that two things to be desired by all steam plant owners and manufacturers in the use of coal and steam generators are economy and smokelessness. Intelligent hand firing is the best agency yet known for securing these but unfortunately intelligent firemen are not easily obtained or retained and in large plants their cost may be prohibitive as compared with the mechanical stoker. Consequently mechanical stokers have been developed in many localities where they have met the demands of economy and *sometimes* of smokelessness.

The large locomotives that have come into common use on most trunk line railroads have made necessary a great many changes in machine shop equipment, as we all know. A case in point is the size and power of the wheel press. A few years ago a wheel press of 300 tons capacity was considered ample for almost any railroad shop, for with the size of axles then in use it was very rare that the ultimate capacity of the press would ever be required, but with increase of locomotive dimensions came the jump from a 7-inch axle to axles 10 inches or more in diameter, and this meant much greater pressure for wheel fits. One of the interesting new tools installed in the Sayre shops of the Lehigh Valley Railroad is a Bethlehem wheel press of unusual design having a capacity of 500 tons. The cylinder is a steel casting cradled in a cast iron housing. The resistance or sliding head is shifted longitudinally by means of two large screws at the top and bottom, these being driven by power.

The State engineering experiment station organized in connection with the University of Illinois, Urbana, has undertaken important work at various times for the benefit of the manufacturing and engineering interests of the State of Illinois. A series of tests is now being arranged upon Illinois coals. Their efficiency is to be determined, not only by chemical analysis and calorimeter tests, but the fuel is also to be tried out under power plant boilers, in gas producers and in residence heating boilers. This is the first time, so far as we know, that any attempt has been made to study fuel economy in the latter type of boiler, it generally being supposed that house heating plants have no economy at all, unless it be in a negative direction. An advisory committee is co-operating with the experiment station, made up from representatives of different engineering societies of the West and assistance will also be rendered by the State Geological Survey.

The Iowa State College Engineering Experiment Station recently made a test on a hard coal producer gas engine in the city electric light plant at Algona, Iowa. A three-cylinder vertical Fairbanks-Morse gas engine, using gas generated from anthracite pea coal in a suction producer was the subject of the test. The unit is rated at 150 brake horsepower at 250 revolutions per minute and was guaranteed to give 1 brake horsepower for 1½ pound of anthracite pea coal for all loads above 75 horsepower. The results of the test show that at 250 revolutions per minute and a brake load of 40.1 horsepower 1.511 pound of coal was required per brake horsepower; at 250 revolutions per minute 82.7 brake horsepower required 1.157 pound; and at 250 revolutions per minute 156.9 horsepower required the consumption of 0.999 pound of coal per brake horsepower. The cost of fuel was $6.00 per ton, thus making the minimum cost per brake horsepower hour $0.00299.

One of the great drawbacks to ballooning has been the cost and difficulty of manufacturing hydrogen gas. Consul-General Frank H. Mason, of Paris, France, says in a recent consular report that a new process for the manufacture of hydrate of calcium has been developed in France by Mr. G. F. Joubert, which product, because of its convenience in making hydrogen gas, will likely have an important influence on that sport or business in the future. The new form of hydrate of calcium is called "hydrolithe" and when pure 1 kilogram will generate 1,150 liters of hydrogen gas. It is safe and easy to handle, can be used for generating gas wherever water can be obtained, and for long flights can be carried as ballast instead of sand, and employed at will for refilling the balloon, which may thus be kept in flight almost indefinitely. As an illustration of the economy of weight that has been accomplished by the substitution of hydrolithe for the purposes of military balloon service, it may be stated that an ordinary field balloon contains, when inflated, about 500 cubic meters of gas, the generation of which by the means hitherto employed requires the employment of materials and apparatus which fill three wagons, each one of which weighs when loaded 3½ tons, and requires in a campaign to be drawn by six horses. All this cumbrous and costly equipment can now be replaced by a two-horse wagon carrying a ton of hydrolithe, which, with the addition of water that can be obtained anywhere, supplies instantly and in controllable quantities whatever gas may be required.

The General Electric Co. are building a type of transformer having thin corrugated shells. The shells are made of sheet iron about 1/32 inch thick, corrugated longitudinally, the corrugations being 3 or 4 inches deep and 2 or 3 or 4 inches pitch according to the size and style of the transformer. The shells are built up by fusing or welding together the previously corrugated sheets by means of an electric arc, using a carbon pencil held in a suitable insulated handle. The pencil is made the negative electrode so as to avoid carbonizing the sheets and making them brittle at the joints. The edges of the sheets are not butted together but are laid together sideways and the two adjacent edges are melted together with the carbon pencil, which becomes incandescent at the point the moment the circuit is completed. It is claimed that the joint is as

strong or stronger than any other part. After the sheets are fastened together in the form of a hollow square they are clamped in shape and taken to the foundry and a base cast around, thus making an absolutely oil-tight structure which is very light and has a high radiating capacity.

According to the *Times Engineering* Supplement, an English patent (No. 12,898 of 1905) has been granted to Mr. L. K. Clark, of the St. Louis Car Company, St. Louis, Mo., U. S. A., for a neat improvement in exhaust silencers or mufflers for two or four-cylinder engines. The silencer consists of two casings or chambers, the one enclosed within the other, but each having approximately the same cubic capacity or volume. In a four-cylinder engine, cylinders 1 and 4 are connected to the outer of the two chambers and cylinders 2 and 3 to the inner chamber. Each chamber is fitted with a series of outlet pipes in such a way that the outlet pipes from the inner chamber fit concentrically within the outlet pipes from the outer chamber. By the arrangement of connection to cylinders the exhaust is discharged alternately to the two chambers, and the outflow from the one chamber in its passage by or through the outlet pipes of the other chamber acts in the manner of an ejector to produce a partial vacuum in the other chamber.

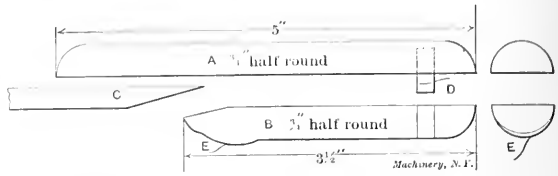
We occasionally receive from the Goldschmidt Thermit Co., 43 Exchange Place, N. Y., descriptions of interesting repair jobs that have been accomplished in welding together broken parts of machinery by the use of thermit. One of the recent repairs was made in San Francisco just previous to the earthquake upon a large forged steel dredge bucket arm measuring 2 inches thick by 12½ inches wide. This was broken squarely off and was effectually repaired by the thermit process. Anticipating the question which naturally arises as to the strength and permanency of Thermit welds, the Goldschmidt Co. had tests conducted at the works of the Fore River Ship Building Co., Quincy, Mass., to throw some light upon this point. Bars of rolled steel 2 inches by 4½ inches were drilled, broken and welded with Thermit and standard test bars cut from the center of the weld. As a basis of comparison test bars were also cut from the unwelded portion of the steel. The following is a condensed report of the tests.

Description.	Elastic Limit.	Tensile Strength.
Weld	32,000	59,000
Stock	38,500	60,500
Weld	33,700	61,800
Stock	36,850	63,400

One of the great widely-advertised scenic features of the Denver & Rio Grande Railroad is the Royal Gorge in the Grand Canyon of the Arkansas in Colorado. This gorge in one place is about 50 feet wide at the bottom and 230 feet in width at the top, while the height of the walls of the gorge is about one-half mile. On account of the narrowness of the gorge there was not room to construct the railway in one place and leave room for the rushing waters, so the novel expedient of building a hanging longitudinal bridge was adopted, it being supported by I-beam trusses set into the rocks on either side and meeting in the center over the stream at an angle like the rafters of a roof. A suspension bridge is now being built across the top of the canyon, says the *Technical World*, which will be 230 feet long and 2,550 feet above the railroad track, making it one of the highest if not the highest bridge in the world. A novel feature of this bridge which, of course, is built almost entirely for the scenic features, is that the floor will be made of plate glass 1½ inch thick set in steel framework through which objects below can be seen. Tourists coming over the Denver & Rio Grande Railroad will be transported to the bridge half a mile above by a roundabout electric railway 12 miles long.

TO REMOVE DENTS FROM GUN BARRELS.

The blacksmith in the rural districts is often called upon to remove bad dents from shotgun barrels that have fallen upon stones or met with some similar accident. Mr. E. C. Johnson describes a simple tool in the *American Blacksmith* for removing such dents. The dimensions are for a 12-gage gun. To make this tool take two pieces of ¾-inch half-round iron, one piece *B* 3½ inches long and the other piece *A* five inches long. Put them together and file them down until they are slack at the muzzle of the barrel. A 3/16-inch rivet is set in the flat side of the long piece *A* about ½ inch from the end. In the short piece a hole is drilled, in which the rivet will fit loosely, to keep the pieces together in the barrel. The piece *B* is filed oval for the greater part of its length leaving the



hump *E*, and the end is beveled, for the spreader or wedge *C*. The spreader is made about 18 inches long which is convenient for most jobs. The tool is placed in the barrel with the piece *B* and hump *E* next to the dent and the spreader *C*, well oiled, is inserted. The dent is heated with a hot iron and a few blows on the spreader with a light hammer do the trick. This tool is very effective on even the more badly dented barrels, though ordinary precaution must, of course, be exercised to prevent the possible bulging of the barrel.

SUPERIOR EFFICIENCY OF HIGH-SPEED STEEL PUNCHES

Engineering Magazine, May, 1906.

The ordinary punch, as is well known, usually gives out by collapsing or breaking off after the edge has become somewhat dulled. The increasing force required to drive the punch through the metal rapidly increases the molecular fatigue or intensifies already existing internal strains until the endurance limit is reached. The limit in high-speed steel is not very well established, but is certainly much beyond that of carbon steel of the best kind. Objection has been made to high-speed punches that, like drills, they are too brittle. The same answer, however, applies, namely, that proper annealing, to give the requisite toughness, obviates the danger of breakage, or reduces it to a minimum. Small-sized punches, however, if working through thick, high-carbon steel, are difficult to temper to just the point at which they will have the required hardness and at the same time be tough enough to stand up. For this kind of work, where the holes are under, say ½-inch, the results with carbon punches seem to be about as satisfactory as can be obtained with high-speed tools, unless the stock is relatively thin. But in all the larger sizes, and in the case of tools for broaching holes in malleable iron, there can be no mistaking the higher efficiency of high-speed punches. A ⅞-inch punch, for instance, punches about 56,000 holes in a ⅜-inch channel iron. The life of a carbon steel punch is about 6,000 holes. This is in the ratio, approximately, of nine to one, a ratio which holds good for nearly all punching operations except as already pointed out.

ENGINEERING REPORTS AS ADVERTISEMENTS.

Engineering Record, April 28, 1906.

The consulting engineer who has worked up a good business without having seen at least one of his reports used for advertising purposes or bolstering bond issues is to be congratulated. The lyric star whose name is given to cigars and the professional "society" chaperon who furnishes a recommendation for tooth powder are paid for the use of their names in advertising matter; nobody is deceived as to the value of the recommendation in such a case. But an engineer who reports confidentially on some engineering appliance or process is rightly disturbed to find extracts from his report of a favorable character used for advertising purposes, while those of an unfavorable character are withheld. This misuse of his report may make it appear that the engineer endorses the appliances or process when, in reality, quite the contrary may be true. The act is very different from the mere abstracting of certain parts of a report in preference to its publication as a whole. The interested parties who distort such a document really commit an act of fraud, for it brings to the public eye certain

things ostensibly supported by authority which, in point of fact, does not exist. Every disinterested man should frown upon this practice, not only for the moral question involved, but for the injury to the engineer who is thus misrepresented.

As an instance of what has been done, take the case of a manufacturer of steam appliances who made a contract with a mill for the remodeling of a boiler plant and the attachment of certain apparatus for the alleged better combustion of the coal, and made a guarantee that he would save on the total quantity of coal burned 30 per cent of the cost of his present fuel; the decision as to the fulfillment of the guarantee being left to an expert who was to test the fuel consumption both before and after the appliance was attached. The steam appliance man noticed that the fireman was inefficient. There were certain leaks about the steam plant and certain wastes that could easily be remedied; and, furthermore, the class of fuel was of an expensive character. In a word, there were opportunities to make various improvements with little or no reconstruction, that would, in themselves, secure a considerable saving in the cost of operation. The coal consumption and the cost of fuel per horse power per hour were determined by the expert, and the new appliance was attached and preparations were made for the second trial to ascertain the fulfillment of the contract. In the meantime the fuel was changed to one which was nearly as efficient, but far less expensive, some insignificant changes made in piping, and some of the fittings were changed by which the leaks and wastes spoken of were remedied, the fireman was instructed in the proper management of the boilers, all being done at the suggestion of the party who put in the appliance. Then the test was repeated. When the result had been determined it was found that the cost of fuel was not only reduced to the extent of the guarantee, but 5 per cent more! and the expert reported to his clients accordingly. The expert stated in his report the condition of the plant before the appliance was attached, and after its installation; and, furthermore, made note of the changes that had been made, and summed the whole up by stating that the aggregate saving was 35 per cent. Thereupon the steam appliance people published an extract from the expert's report to the effect that the application of the appliance had resulted in a saving of 35 per cent and conveyed the impression to the public that, upon the authority of the expert in question, the efficiency of the appliance was represented by this saving. The facts were that a large part of the improvement was produced by the single change in the kind of coal burned to one of a cheaper class and nearly the whole of the remainder was due to the improvement in firing and the prevention of wastes that were going on before that time; in point of fact, the appliance produced barely any improvement whatever.

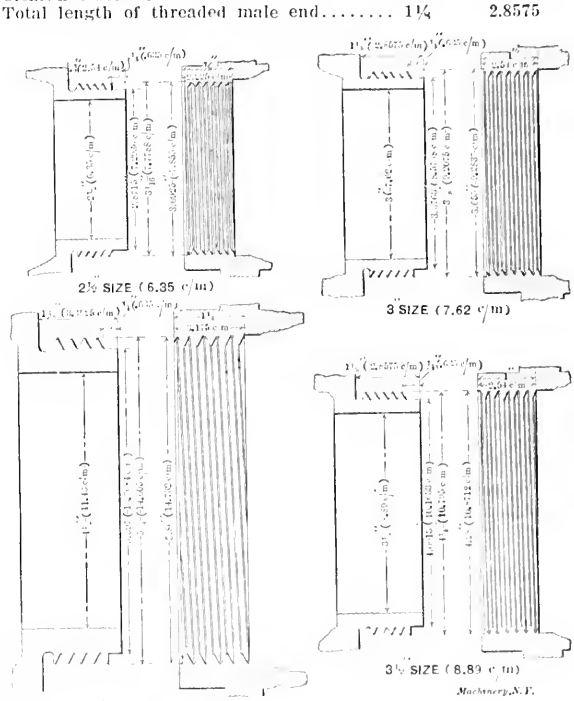
Engineers may ask how the misuse of a report can be stopped, inasmuch as the manufacturer has paid for it to use it as he sees fit. That is true only in part; he can suppress it, of course, or publish it, but he has no right to use an engineer's name to mislead the public for his own profit. It is the privilege and should be the duty of every engineer whose reports are garbled so as to mislead or deceive, to call the public attention to the fact. If the engineer fails to do so, the public will rightly conclude that he was paid to make a report with that object in view. A few exposures will be quite effective in putting a stop to this practice.

PROPOSED STANDARD HOSE COUPLING.

The importance of having standard hose couplings for all cities and towns has long been recognized but unfortunately the movement toward standardization has been very slow. There are now something over 800 sizes of hydrant nozzles in use in the United States where four or five sizes would be ample. Interchangeable standards are of most importance to towns and small cities where in the cases of destructive conflagration it is often necessary to call on neighboring cities for help and, if in such cases the hose connections will not fit the hydrants, there is little that can be done. The consequences often have been that fires have made great destruction simply because of this lack of interchangeability. A recent issue of *Insurance Engineering* shows the four standards proposed by the National Fire Protection Association's special committee, which have received the endorsement of a number of water works associations, firemen's associations, underwriters, etc. It is pointed out that the adoption of the new standards will not necessitate the discarding of the existing hydrants and hose couplings as adapters can be provided at small cost so that the old hose may be used with new couplings or new hose used with old hydrants during the period of transition. Following are the principal dimensions and other data for 2½-, 3-, 3½- and 4½-inch standards:

National Fire Protection Association Standard Hose Couplings.

	Inches.	Centimeters.
Inside diameter of hose coupling..........	2½	6.3500
Number of threads per inch, 7½..........	..	....
Blank end of male part..................	¼	.6350
Outside diameter of thread finished.......	3 1-16	7.7788
Diameter at root of thread	2.8715	7.2936
Clearance between male and female threads	.03	.0762
Total length of threaded male end........	1.00	2.5400
Inside diameter of hose coupling..........	3	7.6200
Number of threads per inch, 6............	..	....
Blank end on male part..................	¼	.6350
Outside diameter of thread finished......	3⅝	9.2075
Diameter at root of thread..............	3.3763	8.5758
Clearance between male and female threads	.03	.0762
Total length of threaded male end........	1⅛	2.8575



Proposed Standards for Hose Couplings.

Inside diameter of hose coupling.........	3½	8.8900
Number of threads per inch, 6............	..	....
Blank end of male part..................	¼	.6350
Outside diameter of thread finished......	4¼	10.7950
Diameter at root of thread..............	4.0013	10.1633
Clearance between male and female threads	.03	.0762
Total length of threaded male end........	1⅛	2.8575

Sixty-degree V thread pattern 1-100 inch (0.0254 centimeter) cut off top of thread and 1-100 inch (0.0254 centimeter) left in bottom of valley. Female end to be cut ⅛ inch (0.3175 centimeter) shorter for endwise clearance. (This applies to the 2½-, 3- and 3½-inch sizes.)

	Inches.	Centimeters.
Inside diameter of hose coupling..........	4½	11.4300
Number of threads per inch, 4............	..	....
Blank end on male part	¼	.6350
Outside diameter of thread finished......	5¾	14.6050
Diameter at root of thread..............	5.3970	13.7081
Clearance between male and female threads	.05	.1270
Total length of threaded male end........	1⅜	3.4925

Sixty-degree V thread pattern 2-100 inch (0.0508 centimeter) cut off top of thread and 2-100 inch (0.0508 centimeter) left in bottom of valley. Female end to be cut ⅛ (0.3175 centimeter) shorter for endwise clearance.

THE GAS TURBINE.

Power, May, 1906.

The proposition to ignite a mixture of gas and air in a tank and utilize the resulting expansion in driving a turbine runner is a highly attractive one, and the mere dilettante is disposed to enthuse over it, basing his enthusiasm on a blind faith in the ability of the real workers in this branch of engineering science to eliminate or surmount the difficulties "somehow." But when men of the class of Clerk, Lucke and Neilson give no encouragement, one's optimism sags dreadfully. Broadly, the apparent insurmountable obstacles are the high temperatures necessary to economy, the inefficiency of the expanding nozzle, and the deficiencies of rotary or centrifugal compressors as compared with the reciprocating type. The maximum temperature in a gas engine is commonly around 2,800 to 3,000 degrees, Fahrenheit, which, of course, would be utterly prohibitive without some means of rapidly conducting the heat from the affected surfaces. In a gas turbine there could be no way of cooling the blades or vanes, and these would be destroyed almost immediately. The apparent remedy is to use an expanding nozzle for converting a large part of the heat energy of the burning gases into kinetic energy, thus lowering the temperature of the gases. But this plan is defeated by the facts that expanding nozzles have not sufficiently high efficiency to enable a gas turbine to compete with a gas engine, and that even with a perfect nozzle the combustion temperature would have to be reduced to about 1,800 degrees Fahrenheit in order to get the admission temperature down to where the blades would stand it. Even if these two difficulties were solved, there remains the inherent inefficiency of the turbine runner as a converter of the kinetic energy of a rapidly moving fluid into work at the shaft, as well as the poor prospect of the rotary compressor. The turbine inefficiency is fundamental and unavoidable. In the steam turbine this is offset by the lack of initial condensation and the utilization by the turbine of the lower stages of expansion. The lack of an efficient rotary compressor, while not a determining factor, is of serious importance. A reciprocating compressor could be used, just as reciprocating pumps are used in steam turbine plants, but the size and cost of the compressor would probably make its use absurd, if not uncommercial.

There are many other difficulties to be overcome before a commercial gas turbine is produced, but these fade into insignificance in comparison with those here considered.

NOTES ON GAS PRODUCERS.

From a Paper by Samuel S. Wyer, read before the Engineers' Society of Western Pennsylvania.

The use of simple producer gas, *i. e.*, gas formed by passing air alone through a deep mass of incandescent fuel, is practically obsolete. The thermal loss by such a process is very high. To reduce this loss and also to insure a better operation of the producer, steam is admitted to the fuel bed. Many producers secure a partial destructive distillation of the coal before it goes onto the fuel bed proper. Thus the modern producer gas is made in a trinity of processes. The simple producer gas, water gas and retort gas processes are combined into one, and this is the secret of its extensive use.

The first gas producer was built in 1839 by Bischof and he was closely followed in 1840 by Ebelmen, who designed and operated three distinct types at a French iron works. These men were closely followed by Ekman in Sweden, Weding in Germany, Beaufume in France, and Siemens in England. Ebelmen understood the problem more closely than any of his contemporaries or immediate successors and anticipated several present-day types of producers. However, Siemens, in 1860, was the first to introduce the gas producer on an extensive scale.

The use of producer gas for power purposes was begun with the introduction of the Dowson producer in 1878; this, with the successful introduction of the Mond by-product process on a large scale in 1889, and Benier suction gas producer in 1895, make three epochs in the development of the gas producer.

The reactions taking place when producer gas is manufactured are not complicated. The fuel bed may usually be divided into ash, combustion, decomposition and distillation zones. However, in practice the line of demarcation between these is not very distinct.

The condition of the fire is of the utmost importance. The temperature must be kept high enough to permit the proper reactions taking place and at the same time the gas should be comparatively cool when it leaves the producer; this is especially true when the gas is to be used in engines. The advantages of "hot" and "cold" gas for furnace work have been vigorously debated in the past, both pro and con. The conclusion seems to be in favor of cool gas, if the cooling can be done in such a way as to utilize the sensible heat abstracted.

The use of preheated fuel and air and superheated steam in the gas producer is very desirable. This is especially true when the preheating and superheating may be done by heat that would otherwise be wasted. In gas power plants, the waste heat in the engine exhaust should be used in this way.

The presence of CO_2 in producer gas is always indicative of improper action in the producer. The deleterious effect of this useless constituent is greater than most people realize. In general, the percentage of fuel wasted by the formation of CO_2 will double the percentage of CO_2 in the producer gas.

The use of steam in gas producers increases the calorific power of the gas, retards clinkering, reduces the inert nitrogen and reduces the sensible heat loss in the gas by lowering its temperature. The steam acts as a carrier of heat energy. No possible use of steam can cause a gain of heat in the producer.

The methods used in introducing the air and steam into the producer are of vital importance. In pressure producers, the steam jet blower is almost universally used for this purpose. It is cheaper, simpler, and costs less than any other type. However, unless properly designed, it may be very inefficient in the use of steam and may become a source of serious loss. The solid jet blower should never be used, as it will always be wasteful. Only those types which divide the steam into thin streams and secure a thorough admixture of the air and steam should be used.

If producer gas is to be used in gas engines, it is necessary to clean it, *i.e.*, remove certain foreign constituents which would give trouble in the engine. The methods for doing this may be divided into five classes: 1. Deflectors; these depend upon the fact that the sudden deflection of a volume of gas carrying foreign matter in suspension will result in the precipitation of a part of the foreign matter. 2. Liquid scrubbers; these remove foreign matter by bringing the gas in contact with a spray, film or seal of water. 3. Coolers; the function of these is to lower the temperature of the gas and thereby precipitate the condensible constituents of the gas. 4. Absorbers or filters; these act by absorbing impurities in the gas. 5. Rotating scrubbers; these are of two types—slow and high speed; the former depends on securing a thorough admixture of the gas and some liquor, usually water; the latter, on the centrifugal force of the impurities in the gas.

The elimination of tar from producer gas is an unusually difficult problem. For this reason, where the gas is used in engines, it is now generally made from coal that yields little or no tar. Tar is a very complex mixture of a large number of chemical compounds which are very uncertain in their reactions unless the temperature of the producer is just right. If tar is brought into close contact with incandescent carbon, it will be broken up into fixed gases. Since bituminous coal, when gasified, will yield tar, the problem of gas power generation from bituminous coal is the problem of getting rid of the tar. This may be done by (1) mechanical separation; (2) washing; (3) destruction in the producer.

Gas producers may be classified as to (1) method of operation; (2) method of supporting fuel; (3) place of removing gas; (4) means of agitating fuel bed; (5) direction of blast; (6) continuity of operation, and (7) nature of draft. In general, they are divided into two classes: pressure and suction. The pressure type receives its blast from a pressure blower; in the suction type, the blast is induced by the pumping action of the gas engine piston.

The reactions taking place in the suction producer are the same as those in the pressure type. Since the rate of gasification varies with the load on the gas engine, it is of the greatest importance that the amount of steam fed to the producer should always vary directly with the load on the engine, if satisfactory results are to be obtained at varying loads. The introduction of the maximum amount of steam at half load, for instance, will soon cool the fire and cause trouble. There are now several devices on the market for securing this regulation. The vaporization of the water is done by three methods: 1. Where the vaporizer is an integral part of the producer. 2. Where the vaporizer is attached to the side of the producer. 3. Where the vaporizing device is entirely distinct from the producer and is heated by the engine exhaust.

Where producer gas is used for power purposes, the gas producer sustains the same thermal relation to the gas engine that the steam boiler does to the steam engine in a steam plant. The gas producer power plant is comparatively new in this country, but it has a brilliant future. It presents the easiest and most practical solution of the elimination of the smoke nuisance. It will also show a marked economy in labor, fuel and water consumption, stand-by and distribution losses and the handling of peak loads.

The by-product gas producer is one that abstracts certain constituents from the gas—which would otherwise be useless—and converts them into certain by-products which have a certain commercial value. The conversion of the ammonia, evolved from the nitrogen in coal, into sulphate of ammonia, is the only process that is now commercially successful. The sulphate of ammonia, being a valuable fertilizer for certain soils, finds a ready market for such purposes. The removal of the ammonia from the gas and its conversion into the sulphate requires a very extensive scrubbing system which must be directed by a skilled chemist to insure a saleable by-product. For this reason, the system is adapted only for large plants.

Producer gas has been used successfully for firing steam boilers; however, this is not generally justifiable and it would be better to use the gas directly in a gas engine and thus eliminate the boiler entirely. In plants requiring steam in the process of manufacture, the use of producer gas under the boilers would be a good practice.

The kind of fuel used for gasification will depend on the use of the gas, type of producer and the locality, the last named determining the commercial value of the raw fuel. For the plant to be successful, the three factors just mentioned must be co-ordinated in their proper relation. Practically every available fuel in this country has been used successfully for the manufacture of producer gas.

There are certain dangers in connection with the use of producer gas, on account of the extremely poisonous nature of the carbon monoxide that it contains. With common sense precautions, no trouble will result from this. However, all persons working around producer gas should be well informed as to its specific dangers and also as to the first aid to the asphyxiated.

ACETYLENE GAS STORED IN ACETONE.

From Paper read before the International Acetylene Association August, 1905, by Eugene Bournonville.

One of the successful methods for the use of acetylene gas without exposing those in the vicinity of the apparatus to the dangers of a possible explosion is by compressing the gas in acetone contained in a tank filled with a porous substance. Acetone is a liquid—an organic compound—for which acetylene gas has a great affinity. One volume of acetone at 60 degrees F. under atmospheric pressure will absorb 25 volumes of acetylene gas; under 12 atmospheres, 300 volumes. Thus the solubility increases in proportion to the pressure at the rate of 25 volumes for each and every atmospheric pressure. It has been determined that acetylene stored in acetone at 150 pounds pressure is safe! But to further guard against explosion the tank in which the acetone and gas are stored is filled with a porous substance which acts as a factor of safety. It has the practical result of holding the gas or liquid under a high state of compression in minute quantities between the fibers of the material which may thus be regarded as stored in vessels whose diameters are less than that in which an explosion can be propagated.

By this method an enormous quantity of acetylene gas can be stored, and transported safely under comparatively low pressure in cylinders of moderate size; and when the pressure is relieved the acetylene gas escapes gradually. The acetone can be used over and over again for the storage of actylene gas, the loss in acetone being only about 1 pound per 1,000 cubic feet of acetylene.

This method of storing acetylene gas is controlled by the Commercial Acetylene Co. in this country and Canada. The porous substance used by them is a very fine fiber of asbestos bound together with silicate of soda and melted in cakes to exactly fill the interior of the cylinder for which they are intended. The porous material must not have more than 80 per cent of porosity. The method of storing acetylene gas in porous material saturated with acetone is as follows:

First. Reservoirs or cylinders made of soft steel are employed and are guaranteed by the makers to withstand 1,200 pounds pressure to the square inch. These cylinders are made by the Air Tight Steel Tank Company, of Pittsburg.

Second. These cylinders are filled completely with sections of porous asbestos, molded to fit and fill completely the inside of the cylinders. The asbestos is inserted into the cylinder by the makers of the cylinders, before the bottom is brazed on to it.

Third. When the cylinder is received at the charging plant of the Commercial Acetylene Company, a high pressure valve is inserted in the head of the cylinder, then the cylinder is connected to a vacuum pump, to exhaust all the air contained in the cylinder.

Fourth. When all the air is exhausted from the cylinder a pipe is attached to the stud valve of the cylinder, and the other end of the pipe is immersed into a quantity of acetone, representing 43 per cent of the entire volume of the inside measurement of the cylinder; then the stud valve is opened and all the acetone is drawn into the cylinder by the suction from the vacuum previously made, and the minute the last drop of acetone has entered the pipe the stud valve is closed tight.

Fifth. When the proper quantity of acetone is in the cylinder, the cylinder is connected to the acetylene gas compressor, and the gas is forced into it until the pressure gage registers 2 atmospheres, or 30 pounds pressure, then the stud valve is closed tight and the cylinder is left in that condition for 24 hours, after which time the stud valve is opened and all the acetylene in excess of the 25 volumes absorbed by the acetone at atmospheric pressure is allowed to escape in the open air. This is done as an extra precaution, in case that all the air would not have been exhausted by the vacuum pump. As the acetone absorbs gas only and does not absorb air when the stud valve is open, the air is the first to come out, being chased by the acetylene, emerging from the acetone.

Sixth. When the gas stops flowing out, the cylinder is ready to be charged definitely, and then to be put into service, which is done by connecting the cylinders to the compressor, and charging to 10 atmospheres pressure.

Data Relative to a Railroad Cylinder of 21 Cubic Feet Capacity.

(All the data following are at 62 degrees F.)

	Cubic Feet.
Inside cubic measurement	21
Asbestos (space occupied by) 20 per cent	4.20
Acetone (space occupied by) 43 per cent	9.03
Space left in porosity when not charged with acetylene gas	7.77
Volume of acetylene gas taken to saturate the acetone	225.75
Volume of acetylene gas absorbed by acetone at 150 pounds pressure after the acetone has been saturated with same	2,257.5
Volume of acetylene gas stored in the empty space left in cylinder	45.40
Total volume of acetylene gas available	2,302.9
Weight of acetylene gas contained in cylinder when charged at 150 pounds pressure	165.62 pounds

Space occupied by absorbed gas	3.23
Space left free in cylinder when charged at 150 pounds pressure, 62 degrees F	4.51
Space occupied by absorbed gas, acetone and asbestos, combined	16.46

THE USE OF OXYGEN IN REMOVING BLAST FURNACE OBSTRUCTIONS.

Abstract of Paper by Chevalier C. de Schwarz read before the May (1906) Meeting of the Iron and Steel Institute.

All experienced blast furnace engineers are acquainted with the great trouble caused by the taphole of blast furnaces becoming closed up with solid iron so that it cannot be opened by ordinary appliances without considerable loss of time. The usual means employed for opening a closed taphole is a steel bar driven by hand rammers, or if these do not suffice, a heavy ram suspended on chains and worked by a dozen men is employed. It sometimes happens that the steel bar snaps off, leaving the broken end in the hole already made, and making matters worse than they were before. Coke and heated blast as well as petroleum have been employed for opening closed tapholes or tuyeres and also a strong electric current but none of these work quickly enough and are besides very expensive. The application of compressed oxygen has worked very quickly and has, besides, the merit of being cheap. The iron to be pierced is first heated at the spot selected for making the hole by means of an oxy-hydrogen flame. The oxygen and hydrogen gases are compressed in two separate steel flasks, each flask being provided with suitable outlet valve. The burner consists of an outer and inner tube, the outer tube supplying the hydrogen and the inner tube the oxygen. The hydrogen is turned on first after which the stream of oxygen is turned on. The pressure of both gases is first kept low, but is gradually raised and regulated in such a way as to give a very hot flame which heats the spot upon which it impinges to a white heat. The pressure of the oxygen is then raised to such an extent that the iron commences to burn, which is shown by sparks being thrown out. Thereupon the pressure of the oxygen is increased to about 450 pounds per square inch while the supply of hydrogen is entirely shut off. It is now that the iron burns, thus replacing the hydrogen as a combustible, whereupon a degree of heat is developed which far surpasses that produced by the oxy-hydrogen flame. The high pressure of the escaping oxygen at the same time served to force out all the molten iron, thus keeping the hole burned through perfectly clean throughout the operation. This explains why it is possible to perforate a solid block of cold iron or steel say 16 inches thick. Moreover, this extraordinary feat can be performed in one or two minutes, it is claimed.

The explanation of the great increase of heat due to the use of pure oxygen will not be without interest. Burning 1 pound of hydrogen with oxygen produces 62,000 B. T. U., while burning iron with oxygen produces 2,968 B. T. U. but at atmospheric pressure 1 pound of hydrogen occupies over 80,000 times as much space as 1 pound of iron. Therefore a certain volume of iron when burning with oxygen produces about 4,000 times as much heat as an equal volume of hydrogen in the same space. In other words, when iron burns in oxygen the heat evolved is concentrated on a very small area. This explains the enormously high temperature produced and the quick action, notwithstanding that at the same time the temperature of the compressed oxygen is low because of its compression and subsequent expansion. This is indicated by the fact that the tube leading to the oxygen flask to the burner often becomes coated with ice, the temperature of the tube often being only about 14 degrees F.

So intensely local is the heating effect that the flame may be directed so as to clean out a thin slag tuyere hole 1⅜ inch diameter without injuring it in any way. Moreover it may be used for piercing armor plate for battleships. A hole through such a plate say 9 inches thickness would require two or three hours if drilled in the ordinary way, while with the compressed oxygen flame it may be perforated within 15 or 20 seconds! In rolling mills where an interruption of the work is very costly the oxygen process may often be advantageously used in melting through and quickly removing broken couplings, flywheel hubs and other parts which require much hand labor when done by means of chisels and drills. So certainly can the action of the oxygen flame be controlled that it has been used for cutting off boiler tubes and for cutting boiler plates to any required shape. It is said that the apparatus for guiding the tubes works in such an easy and exact manner that the slightest pressure of the hand suffices to guide it exactly as desired. The cost of oxygen gas is quoted as being about 75 cents per thousand cubic feet. For opening up a blocked taphole or a tuyere as a rule not more than 8 or 10 cubic feet of oxygen are required and in exceptional cases sometimes 20 to 40 cubic feet are used, hence in the extreme cases the use of the new process is not at all expensive. Moreover the apparatus is very simple and easy to maintain. Inasmuch as the hydrogen is only used to start the process it follows that any other means of raising the initial temperature to the required degree will allow the oxygen process to be used, hence preliminary electrical heating can be used instead of the oxy-hydrogen flame, and this has been done.

A NEW METHOD OF PUMPING HEAVY CRUDE FUEL OIL OR OTHER THICK VISCOUS FLUID.

John D. Isaacs, in *Engineering News*, June 7, 1906.

The crude oil product of most of the California fields is a very heavy, thick and viscous fluid with an asphalt base. The entire product of the Kern River fields, near Bakersfield, is particularly heavy, its density averaging about 14 degrees Baume. Up to the present time, this oil has been transported from the fields in cars. Although attempts have been made to facilitate its movement by long pipe lines, these trials have met with little success, as it was found necessary to use very high pumping pressures, necessitating expensive pipe and powerful pumping plants placed so close together that operating expenses became too high for practical economy, and moreover with such a plant the delivery was very small.

Various attempts were made to overcome these difficulties, the most important being the heating of the oil. This was a decided help in short pipe lines, but a temperature sufficient to be effective for long distance pumping caused the disintegration of the oil and the deposit of asphaltine, called by the oil men "carbonizing," thus clogging the line. Water was also introduced with the oil, but 30 per cent of water was needed to materially improve the results and the surging of the mixture through the line soon caused an emulsion of the oil and water, which is very difficult and expensive to separate, necessitating heating the oil to 180 degrees F. The mixing of the lighter oils with the heavy oils has made it possible to pump the mixture, but in the fields where only the heavy oils are obtained, this necessitates the pumping of the light oils to such fields from long distances, and as the mixing of the oils causes a loss in the value of the light oils, which have a market value much higher than the heavy fuel oils, the process is very expensive.

A new process has been adopted by the Southern Pacific Company which has led to the construction of a "rifled pipe line." The method is to rifle the pipe, giving it an interior appearance similar to that of a rifle barrel, while a small percentage of water is pumped with the oil. The rifling of the pipe causes the entire liquid mass to whirl, and as the water is heavier than the oil it is thrown to the exterior of the mass, thus causing the envelopment of the oil with a thin shell or film of water. This forms a water lubrication between the oil and the pipe, greatly reducing the friction and allowing the plug or core of oil to glide through the pipe readily.

When this principle was discovered the first experiment was made with a small lead pipe. In the process of drawing ordinary lead pipe the interior surface is slightly scored in close longitudinal lines. The pipe was first used as received and friction co-efficients determined; it was then twisted by hand, causing these longitudinal scorings to become helical, which was sufficient to cause a rotation of the oil and water when passed through the pipe. Experiments made with this

rifled lead pipe indicated the soundness of the principle and led to an experiment on a larger and more practical scale. One-half mile of 3-inch standard line pipe was used in the next experiment, which was performed by the Southern Pacific Company at West Oakland. The pipe was first rifled by the insertion of helical wires. This was accomplished by simply drawing tempered steel wire from a coil through the pipe in lengths of 500 feet at one time, the spring of the wire causing it to cling closely to the sides of the pipe, forming a helix. This pipe was then laid and subjected to an exhaustive experimental operation with heavy Kern oil. The best results were obtained by pumping about 10 per cent. water with the oil. A flow was obtained many times that obtained by pumping pure oil, or oil and water, through an ordinary plain pipe. The 3-inch line was then rifled, by passing the pipe through a series of rollers, to a pitch of 1:5 with the line of the pipe. Experiments on these lines gave even better results and lower co-efficients than those from the lead pipe and justified the construction of a practical rifled pipe line for transporting oil commercially.

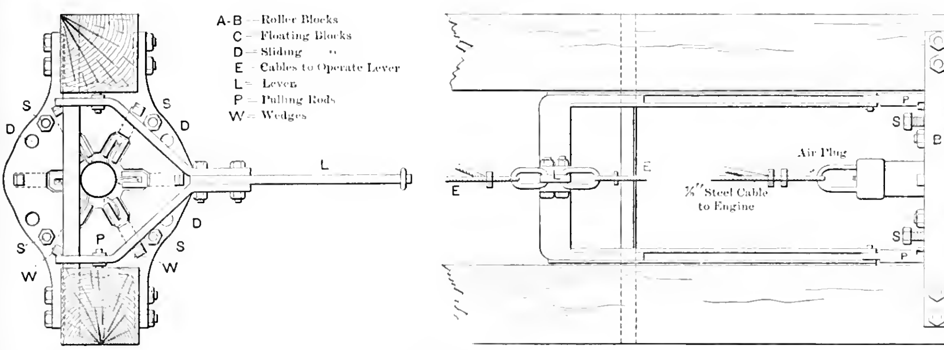
A rifled pipe line was finally constructed 31.17 miles long, between Volcan, a point located centrally in the oil fields and on the Southern Pacific Company's railroad, and Delano, another station northward on the same railroad at an elevation of 120 feet below Volcan. The pipe used was standard 8-inch line pipe, weighing 28.2 pounds per foot, fitted with recessed line couplings and tested to 1,200 pounds per square inch. The pipe was laid in a ditch to a depth of about 2 feet and screwed together by four pairs of 8-inch lay tongs handled by sixteen men. The ditch was dug about 18 inches wide and the pipe laid zigzag within the easy elastic bending of the pipe to provide for expansion by heat. In the vertical plane, the pipe was also laid with a vertical zigzag or wave of about 400 feet in length or shorter, the depth of these waves being about the diameter of the pipe, so as to form traps at 400 feet intervals. The object of these traps is to accumulate water at frequent intervals when the line is shut down, thus preventing the formation of a long plug of solid oil, and facilitating the restarting of the line.

The line was first tested with water and all breaks and leaks repaired until the entire line held 1,000 pounds pressure. The line was next subjected to a continuous operating test, lasting 24 days. During this run an average of over 14 barrels, net oil, in 24 hours, was obtained for the entire run at an initial pressure of 800 pounds per square inch. For several hours at various parts of the test over 675 barrels of net oil per hour was pumped at 800 pounds. The oil furnished was exceptionally heavy and had stood for a long period in an earthen storage reservoir so that much of its light constituents had evaporated. The temperature of the oil was below 60 deg. F. when received at Delano, and in no case was over 75 degrees F. when received at the pumping station, averaging much lower. Experiments show that the maximum flow of oil was obtained when about 10 per cent of water was used. At the end of the line, the water and oil were found entirely separate and when run into the settling tanks the water was easily tapped off, leaving only about 1 per cent in the oil shipped. From Delano the oil was shipped away in cars for commercial use.

The pumping station consists of three 200-horsepower boilers of the return tubular type fitted with water heater, duplicate feed pumps and pressure burners. The main pump is a compound duplex steam pump, 25 and 12 inch steam cylinders with 9½-inch oil plungers with 36-inch stroke. The auxiliary water pump is a duplex plunger steam pump, 16-inch steam cylinders, 5-inch plungers and 12-inch stroke. The oil supply tank is placed 30 feet above the oil pump and a 27-inch suction pipe about 100 feet long is used, thereby insuring an ample supply for this pump. The water is injected by means of a special injection nozzle. A piece of 7-inch well casing is introduced inside the 8-inch pipe; oil passes through the inner pipe and water is introduced through the annular space between the two pipes, both thus starting off in their proper relative position. A short baffle, or twisted plate, is placed in the inner tube at this point to give the oil an initial whirl.

The pipe was "rifled" in the following manner by the machine shown in the accompanying sketch: The large disks *A* and *B* carry six rollers, each mounted in roller fork bearings. The central disk *C* is a floating disk, to which are attached wedges *W*, these wedges tapering outward on both sides of the disk, one wedge being opposite each roller fork, and engaging therewith. When the disks *A*, *B* and *C* are apart, the rollers are open wide enough to allow a pipe coupling to pass freely between them. By means of the pulling rods *P* operated by the lever *L* the three disks are drawn together to any limit set by the adjustable stud bolts. This drawing together of the three disks causes the wedges to thrust the roller forks toward a common center, that is, indent them into the pipe to any desired depth. The rollers were set to a pitch of about 1:5 with the line of the pipe. The disks are so spaced that each roller in disk *A* lines up with the one just to the right in disk *B*, so that when the pipe is drawn through it rotates one-sixth turn between the two disks. Thus, for one turn of the rifling in 10 feet of pipe, the disks would be one-sixth of 10 feet apart in the closed position, or 20 inches. The circumference of an 8-inch pipe is about 25 inches, so that the pitch of rollers to correspond to one turn of rifling in 10 feet would be as 25:120. The male thread of each length of pipe was fitted with a pulling plug, having an air vent, and a testing plug on the coupling end by which water was introduced. The pipe was filled with water, the pressure raised to 1,200 pounds, and then released. If the pipe stood the test satisfactorily, it was placed in the rifling machine, the rollers being closed just behind the pulling plug so as to indent the pipe to a depth of 3/32 inch. By means of a hoisting engine and a pair of triple blocks, reeved with a ⅝-inch steel cable, the pipe was drawn through the machine, the rollers describing six helical paths around the pipe, one complete turn in each 10 feet. The result was a pipe spirally indented and having the appearance of being rifled when looked into at one end. The rollers were then opened, the pipe drawn out, and subjected to 1,200 pounds water test. During the operation of the machine, the rollers were flooded with lubricating oil.

The results show that the rifled process increases the flow of net oil through a long pipe line eight to ten times that of the plain pipe under similar conditions as to diameter of pipe, pressure, etc.



Rifling Machine for putting Spiral Grooves in Pipe.

ESTIMATING WEIGHTS OF FILLETS AND ROUND CORNERS.

In estimating the weight of a casting it is not usual to make any allowance for fillets and round corners. They generally are so small as to not make much difference in the final result and are quite likely to balance each other as well. That is to say, the weight that would have to be added if the fillet were taken into account will ordinarily just about balance that which would have to be subtracted if the rounding of the corners is considered. In castings, however, where rounds of large radii are used either for corners or edges it often becomes necessary to take them into account. To assist in doing this in the simplest manner the following method of procedure may be helpful.

Take the case of the casting shown in Fig. 2. This does not look like any piece that was ever made for a practical purpose, but it will serve us well enough in illustrating the principle involved. First consider the piece as being composed of two cylindrical portions, one of them 3 inches in diameter by $2\frac{1}{4}$ inches long, the other $\frac{7}{8}$ inch in diameter by 1 inch long. To make a truly cylindrical body of this piece it will be necessary to add to it a piece like that shown in section in Fig. 1 to change the round corner to a square one, and we will also have to remove a piece like that shown in section in Fig. 3, an operation equivalent to removing the fillet. In the same way to get the weight of the body we may first obtain the weights of the two cylindrical portions whose dimensions were given above, and subtract from the sum of these weights that of Fig. 2 and add to it that shown in Fig. 3.

The volumes, and from these the weights, of these two imaginary bodies may easily be obtained by considering them as being "solids of revolution." This term means that Fig. 1, for instance, is generated by the area $A\ B\ C$ rotating about the center line of the figure. The volume of such a solid is equal to the area of the figure $A\ B\ C$ multiplied by the circumference of the circle made by the center of gravity of $A\ B\ C$ in its revolution. If the center of gravity lies in line $y\ y$ it will be a distance R, from the center and the length of the circumference of the circle which it makes will be equal

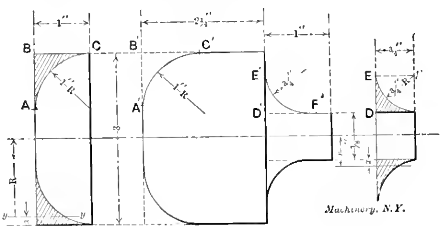


FIG. 1 FIG. 2 FIG. 3

to $2\ \pi\ R$. The volume and the weight of the solid in Fig. 1 are thus equal to that of a body of similar material having a similar cross section, $A\ B\ C$, and a length at right angles to the section of $2\ \pi\ R$. The same may be said of the solid in Fig. 3, which will be equal to a body having cross section $E\ D\ F$, and a length perpendicular to this section equal to $2\ \pi\ r$.

The area $A\ B\ C$, left after subtracting from a square with a 1-inch side, a quadrant with a 1-inch radius, has its center of gravity located at a distance of about 0.22 inch from either of the straight sides of the figure. For any similar figure this dimension, x, will be equal to 0.22 × the radius. This gives us a simple means of finding the dimension R. In Fig. 1, X is equal to $0.22 \times 1 = 0.22$. R evidently equals $1.5 - 0.22 = 1.28$. The circumference of the circle made by the center of gravity of the section is then equal to $2 \times 1.28 \times \pi = 8.0425$ inches. This multiplied by the area of section will give us the volume of the figure. The area may be found by subtracting from the area of a 1-inch square $\frac{1}{4}$ of the area of a circle having a 1-inch radius. The following table (see data sheet in supplement) has been prepared, giving the areas of these sections for radii from 1/16 inch up to 5 inches. Other columns are also given in which are computed the weight per foot and the weight per inch of these sections of fillets for steel, cast iron and cast brass. Using this table we find that the weight of the body if made of cast iron will be equal to $0.0559 \times 0.0125 = 8.4495$ pounds.

To find the weight of Fig. 3 we proceed in a similar manner. $r = 0.4375 + (0.22 \times \frac{3}{4}) = 0.6025$. The circumference of the circle traced by the center of gravity of the section will then equal $2 \times \pi \times 0.6025 = 3.7856$. From the table in the supplement, the weight per inch for a cast iron fillet section having a $\frac{3}{4}$-inch radius is equal to 0.0315 pounds. The weight of the figure is then equal to $3.7856 \times 0.0315 = 0.1192$.

To find the total weight of the body in Fig. 2 use may be made of the following tables, see data sheet supplement, for

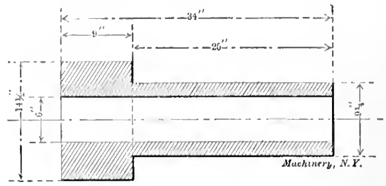


Fig. 4.

solid cast iron cylinders. These tables give the weight per inch for such figures. A 3-inch cylinder 1 inch long is found to weigh 1.98 pound. A cylinder 3 inches in diameter $2\frac{1}{4}$ inches long will, therefore, weigh $1.98 \times 2\frac{1}{4} = 4.455$ pounds. In a similar way the smaller cylinder, which is $\frac{7}{8}$ inches in diameter by 1 inch long is found to weigh 0.1684 pound. As explained in the first paragraph, to obtain the weight of the body in Fig. 2 we must add the weight of the two cylinders to that of the solid in Fig. 3 and subtract from it that of the solid of Fig. 1. Performing these operations we have $4.623 + 0.119 - 0.449 = 4.293$ pounds or the desired result.

A further example may be given to show the use of the table of weights of solid cast iron cylinders when it is desired to compute the weight of hollow cylindrical bodies. Let us estimate the number of pounds in the casting shown in Fig. 4. To do this find the weight of a cylinder $14\frac{1}{2}$ inches in diameter by 9 inches long, add to it the weight of a cylinder $9\frac{1}{4}$ inches in diameter by 25 inches long and subtract from the total the weight of a cylinder 6 inches in diameter and 34 inches long. The example is performed below:

$$
\begin{array}{r}
46.23 \times 9\ =\ 416.07 \\
18.81 \times 25 =\ 470.25 \\
\hline
886.32 \\
7.92 \times 34 =\ 269.28 \\
\hline
617.04 = \text{Ans.}
\end{array}
$$

This table has been used by its compiler for a number of years and he vouches for its accuracy. Allowance is made in it for shrinkage, swelling of cores, etc., so that it is perhaps more strictly accurate as applied to rough castings than to finished ones.

* * *

The brazing of gray cast iron is made difficult because of the presence of free carbon or graphite, in the iron. To braze cast iron successfully it is first necessary to decarbonize it in the vicinity of the joint, and then the action of the spelter is the same as with wrought iron or steel. This is the principle on which most, if not all, of the various cast iron brazing compounds on the market are used. The usual decarbonizing agent is sub-oxide of copper, which when heated in conjunction with cast iron oxidizes the carbon and deposits free copper in the iron, thus not only decarbonizing the iron but giving it a preliminary coat of copper which readily takes the spelter. The spelter is then applied with a suitable flux and treated in exactly the same manner as with ordinary brazing.

* * *

The idea of making the bottom steps of a long staircase of progressively greater height as they approach the bottom has recently been patented. The scheme is supposed to prevent congestion at the bottom of the stairway, as people will descend faster at the lower end of the staircase than at the upper. This idea is ingenious, but it has the fault of making the steps of uneven height and this tends to cause stumbling.

EXPERIENCES WITH AN ALLIS-CHALMERS TURBINE.

The first large steam turbine to be built and started up in this country by the Allis-Chalmers Co. was one of 5,500 K.W. rated capacity, installed at the Kent Avenue power house of the Brooklyn Rapid Transit Co. The contrast between the time required to place in successful operation a turbine unit of this size and a vertical reciprocating engine of corresponding power is illustrated in a striking manner by the record made in placing this turbine in running condition. The turbine and its direct-connected generator were ready for operation on February 1, but the boilers and auxiliary apparatus were not completed until late in March. While left idle for several months the insulation of the generator windings naturally became damp, and therefore, as soon as steam was available, the turbine was started up at part speed to dry out the generator. While this drying-out process was in progress a mishap at another power house left the railway company short of power and an urgent request was made of the Allis-Chalmer Co.'s representative to place the new turbine under load. Additional boilers were therefore fired up and tests were made of the insulation, indicating that the generator was safe for the rated voltage of 6,600. The turbine was then started and run at the full speed of 750 revolutions per minute for the first time since the installation, and an hour later an increasing load was put on until the machine was delivering 3,000 K.W., which was all the railway company needed. Two hours later more load was called for and the turbine was allowed to deliver 4,000 K.W. On the following day the load ran up to over 5,000 K.W. and on the succeeding day it reached 7,000 K.W.

Three days later an opportunity was afforded for opening the turbine casing for examination and here an agreeable surprise awaited the engineers. Heretofore in the operation of turbines there has been more or less trouble from the casing arching upward under the effect of superheated steam on account of the top of the cylinder expanding more than the bottom, this being due to the fact that the casing has not been made entirely symmetrical, sometimes having ribs or heavier parts on the bottom than on the top part. In a considerable number of instances this has caused the blades to come in contact with the cylinder and be ripped out. In the design of this turbine it was sought to overcome the distortion of the cylinder by a more equal distribution of the metal and at the same time the turbine drum was placed slightly above the center of the cylinder to assist in preventing contact of the blades in case of distortion. When the turbine was opened up, however, it was found that the compensation for distortion had been slightly overdone and that the casing had sagged a small amount, and this, together with the high position of the drum, had caused the blading to rub hard for nearly a third of the length of the turbine. The drum was therefore lowered a few thousandths of an inch at each end, which has prevented further rubbing. In the January, 1906, issue of MACHINERY the details of construction of the Allis-Chalmers turbine were shown. The leading characteristic is the system of blading, whereby the blades are built up into rings which are afterwards inserted in grooves in the rotor and stator of the turbine. The outer ends of the blades are supported by a channel-shaped shroud to which the blades are riveted, which makes a stronger and safer construction than where the outer ends of the blades are both unsupported and unprotected. One trouble with the Parsons type of turbine has been that in case of the blades rubbing or of any foreign substance getting into the turbine, some of the blades would be ripped out, since in case the interference came at

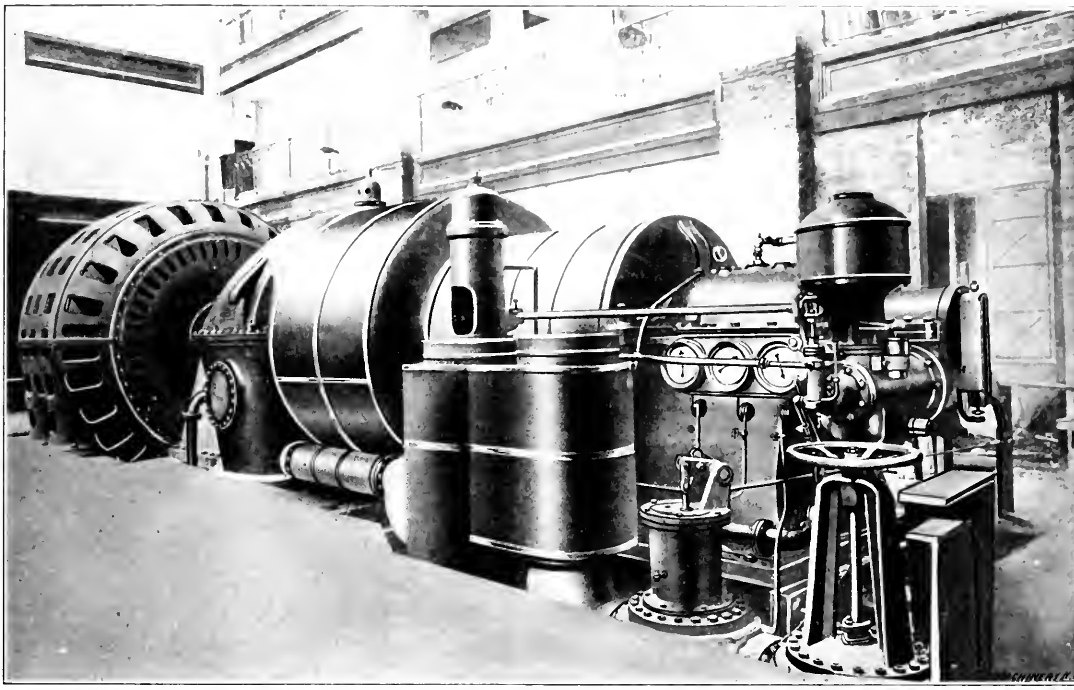


Fig. 1. Allis-Chalmers Turbine of 5,500 K.W. Capacity, at Kent Avenue Power House, Brooklyn, N. Y.

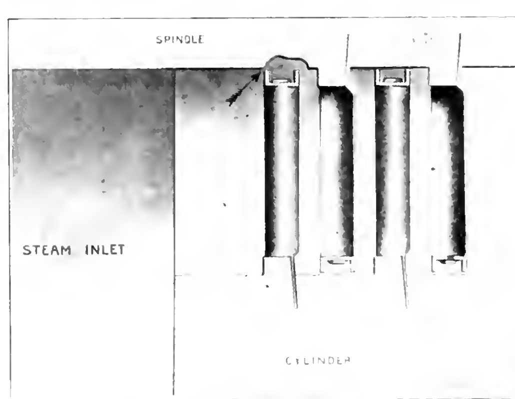


Fig. 2. Sketch to Illustrate Severe Treatment Received by Turbine without Damage to Blading

the outer ends of the blades there would be sufficient leverage to break the blades at the points where they are unsupported. In the case cited above, the blades were wholly uninjured and no damage whatever was done to the turbine.

A still more interesting incident was discovered after the turbine had been in continuous operation for nearly a month. It was found that a large jack-knife had been left inside the turbine which had been running with a knife blade wedged in between the rotor and stator and the latter part of the time with the shrouding of the blades grinding against the stator; yet when opened up it was found that no destruction of the parts had occurred and there was no damage done to the blading. The possibility of some foreign substance or an object like a knife or a monkey wrench being accidentally left inside the turbine casing has not, of course, been taken into consideration in steam turbine design; but the fact that this machine was not damaged by such an obstruction indicates that the method adopted for blading has overcome the difficulties arising from contact between the stationary and moving elements from whatever cause this condition arises.

At the time of the discovery of the knife the turbine was opened because a peculiar noise was heard in the turbine cylinder when starting up on that morning. A piece of steel had gotten between the spindle and the shroud of the first row of stationary blades, and acting like a lathe tool, had cut into the body of the drum for a width of about three-eighths and for a depth of nearly three-sixteenths of an inch, this cut being inside of and opening into the groove which holds the first row of spindle blades in Fig. 2. This had loosened the calking strip which held the ring of blades in place. For a distance of 5 or 6 inches this strip had come partly out of its groove, thereby loosening the ring of blades. This latter under the influence of centrifugal force had bent outward so that the channel-shaped shroud ring had rubbed hard in the bore of the cylinder, and the flanges of the ring had been worn down almost to the heads of the rivets

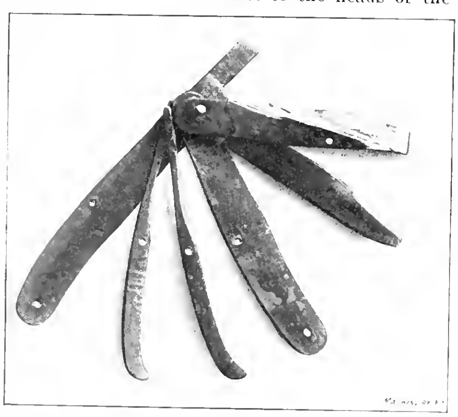


Fig. 3. Large Jack-knife Accidentally left Inside of Turbine Casing, where it Received Harsh Treatment.

which hold the ring to the blades. Not a single blade, however, had come out or even become loosened or injured in any way.

Not wishing to keep the turbine out of service long enough to make permanent repairs, the erecting engineer removed this one ring of blades, closed the cylinder and immediately put the turbine back into service. Fig. 3 shows the knife after it had been subjected to the grinding within the turbine, which shows the harsh treatment it received and indicates the rough usage, also, to which the turbine must also have been subjected.

THE GLEASON GENERATING BEVEL GEAR PLANER.

Many of our readers, of course, are familiar with the gear planer of the template type built by the Gleason Works, Rochester, N. Y., in which formers of the required tooth shape guide a planing tooth in cutting the teeth of bevel gears. These formers represent a section of a tooth of a bevel gear of the required cone angle taken at a point say two or three

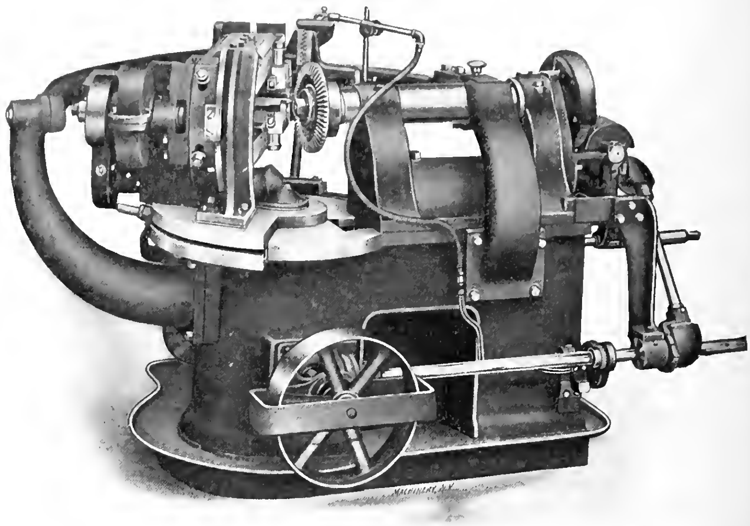


Fig. 1. New Generating Bevel Gear Planer made by the Gleason Works, Rochester, N. Y.

times as far removed from the apex of the gear as is the middle section of the teeth of the gears planed; consequently slight local errors of shape of the formers are reduced in the copying process.

These machines do excellent work and are well adapted for cutting gears of the coarser pitches. They are not, however, so accurate or rapid for cutting large quantities of gears of the finer pitches as a new type of bevel gear planer recently

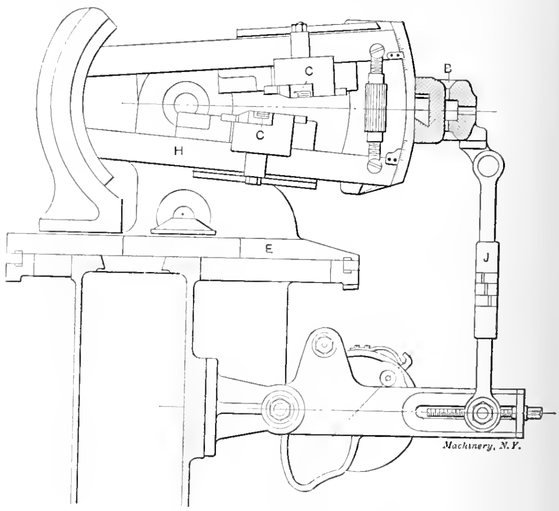


Fig. 2. Showing Slides Carrying Cutting Tools.

developed by the Gleason Co. in which the shape of the tooth outline is generated without the use of any formers whatsoever. In this machine two cutting tools are in operation simultaneously and the action is entirely independent of formed surfaces, save those of the simplest types, *i.e.*, cylindrical and plane. The two tools working on a tooth at once double the speed of cutting, balance the thrust of the cut and minimize vibration. This construction also cleverly avoids the inter-

ference of the tools likely to occur near the apex of long face gears if working in the same direction coincidently.

The general appearance of the machine is shown in Figs. 1 and 3 which are views taken from opposite sides; Fig. 4 is a line cut showing a plan view of the machine with a bevel gear blank A in position on the work spindle F. The two cutting tools referred to in the foregoing, one of which is at C, represent adjacent teeth of a crown gear, their lines of cutting action, of course, being radial to the sphere. The sides of the tools are straight and as they form the bevel teeth by the molding planing process it follows that the shape of the tooth is of the so-called "octoid" form identical with that produced by the Bilgram bevel gear planer. As the bevel gear blank rolls in the Gleason machine, the slide carrying the cutting tool moves coincidently with it but in a vertical plane, the movement being analogous to that of a rack meshing with a spur gear, although radial and its center of motion corresponding, of course, to the center of the imaginary crown-wheel. During this period of engagement of the imaginary crown-wheel with the bevel gear blank the cutting tools reciprocate and plane both sides of the tooth to the correct theoretical shape throughout its length. Preferably the blanks are first roughed out on another machine so that about all that the generating machine has to do is to take off a "skin" cut. This practice is considered best for, while the generator is well adapted to cutting teeth from the solid, time is saved by adopting the roughing process on another machine and doing the finishing process on the generator. The tools will last from 12 to 36 hours when used for finishing alone, and this is an important consideration. The function of the generator is really that of a precision machine which puts on the finishing touch of what is a delicate operation; that is, forming an accurate gear tooth contour.

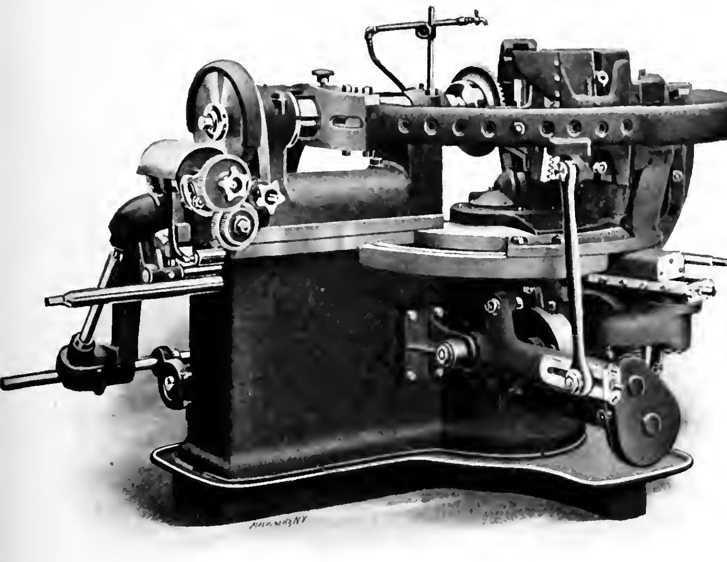


Fig. 3. Rear View of Gleason Gear Planer.

The slides carrying the cutting tools are relatively adjustable, as will be seen by referring to Fig. 2, the feature of adjustability being necessary to adapt them to various tooth angles. The circular turntable or turret, E, on which they are mounted is also adjustable in a horizontal plane for cone angles and an independent automatic action of the turret is given in this plane which will be explained later. Motion for the reciprocating tool slides is conveyed up through the center of the turret but the oscillating motion of the slides in a vertical plane is communicated through a semi-circular swinging arm, B, by the toothed connection shown in Fig. 4; this arm is keyed to the work spindle, F. The working connection to the tool slide arm, H, is made through a crown-wheel segment attached to H, and a change bevel segment, D, mounted on the oscillating arm. The cycle of operations in planing a tooth already roughed out is substantially as follows:

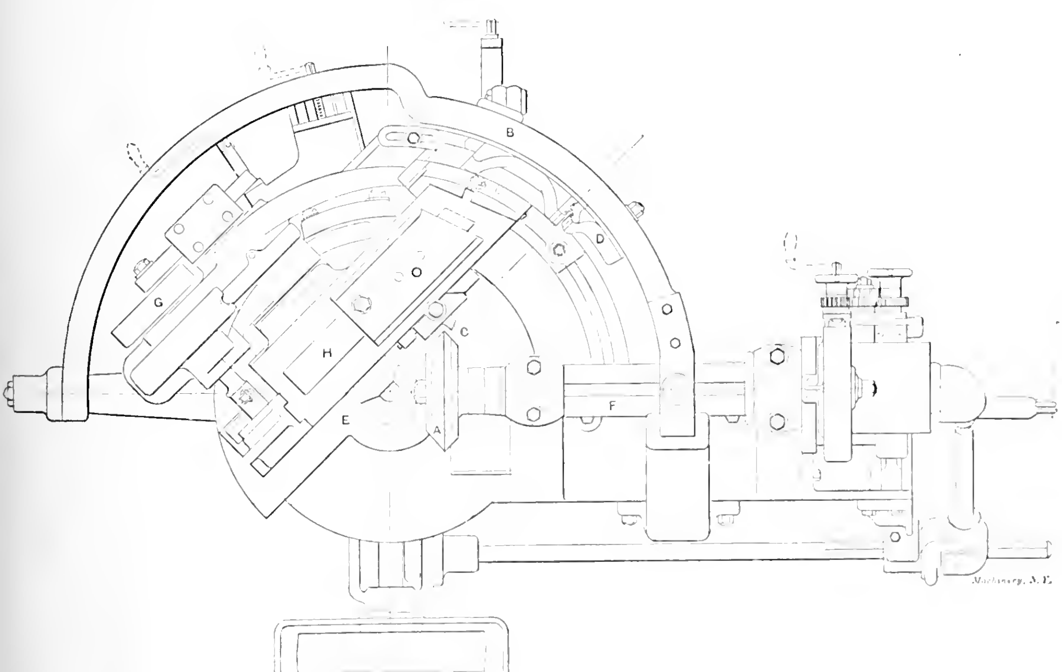


Fig. 4. Plan View of Gear Planer.

The generating process of the tooth begins with the oscillating slide in the middle position. The slide arm moves downward to its lowest position and the gear blank rolls with it at the same rate, measured on the pitch lines, the cutting tools meanwhile reciprocating and planing each side of the tooth to shape. Having reached the lowest point of engagement the action reverses and the slides and blank roll together to the highest point of engagement, again reverse and return to the center; thus, the tools pass over the same surface twice. With the slides in this central position the turret automatically moves the tools out of the plane of the tooth just formed and the gear is indexed one space, whereupon the

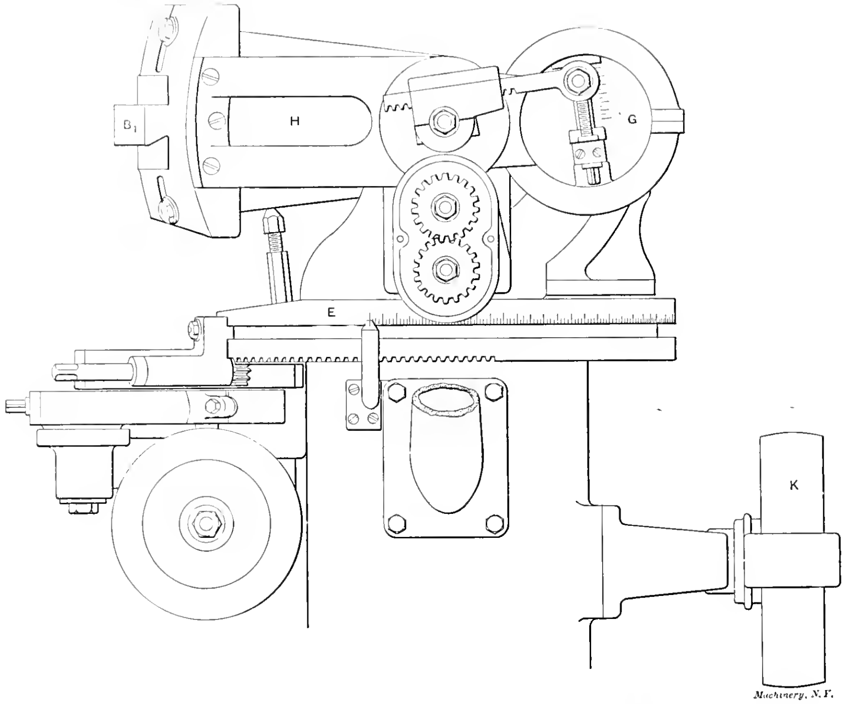


Fig. 5. Elevation showing Mechanism for Operating Reciprocating Slides.

tools are returned to the cutting position and the cycle of operations is repeated and so on automatically until the gear is completed.

Perhaps the most difficult feature of design of the generating gear planer of this type was the provision of mechanism which would move the cutting slide representing the crown wheel and the gear at the same velocity ratio. It will be understood that the pitch line of the crown gear represented by the cutter slide is unchanging in its pitch diameter, whereas the diameter of the pitch line of the bevel being planed changes with the cosine of the angle made by the axis with the side of the cone. The first design of the Gleason generating machine brought out had a compensating device connecting the oscillating arm with the spindle which gave an approximate agreement of velocity ratio for all angles of bevel gears likely to be met with in ordinary practice, but inasmuch as it was not theoretically correct it was subject to some criticism. In this machine a bevel segment, *D* (of which nine are provided) corresponds to the angle of the gear being cut, either exactly or approximately and gives the direct and accurate coincident movement of the blank and cutter slides for all bevels within the machine's capacity.

* * *

WATERPROOF CEMENT.

A German patent has been granted for a cement of which the inventor claims a one-half inch thickness will make any brick wall absolutely waterproof. To each 200 pounds of Portland cement clinker is added a mixture of ¾ pound of Japan vegetable or berry wax, and 1 ounce of caustic lime which has been dissolved in 14 pints of boiling water. These ingredients are thoroughly mixed and when cooled are dried and all are ground together very fine.

THE OLD MAN GETS A JOKE ON US.

A. P. PRESS.

You remember a month or so ago I wrote you of a joke we got on the "Old Man"; well, the boot is on the other foot this time, the "Old Man" got a joke on us. I don't think he meant to, but he did it just the same.

You see he has a bad habit when he comes down through the room; if he sees a press running and the work lying near it, he will take a piece and shove it under the punch and put his foot on the treadle—just the same as a boy gives a crank a turn because he likes to see the wheels go round.

Well, Bill had just finished blanking out a lot of sprockets in the big press—the one with the gear—and he had started taking out the dies. He loosened up the bolts and pulled the bed ahead about an inch, and then the boss called him to give him a lift on a die bed, and he went off and left the press running. That is a thing he ought never to have done anyhow, and as bad luck would have it, just then the "Old Man" came along. There was a piece of stock laying there which was too short to make a full blank, so Bill didn't blank it out. The "Old Man" laid it on the die, and put his foot on the treadle. Of course it didn't punch it; it just nipped it between the end of the punch and the face of the die; and it brought that big press up all standing. The "Old Man" gave one look and went over to the boss and said, "That big press is stuck, and you had better get it off the center," and off he went.

Bill and the boss went over to the press and tried to get it off the center by holding back the clutch and then starting it up, and when it got at full speed, letting go the clutch. Almost always that will do it, but in this case it was too far back of the center, so they tried crossing the up-and-down belt, and then doing the same trick with the wheel running backward, but it was no use—it wouldn't budge a bit. Just then the whistle blew, but, as it would never do to leave a press stuck on the center all night, that whistle didn't cut much ice with us. As it may interest some of your readers to know how we did start it, I will go into detail a little.

We took out all the bolts that held the slides to the bed of the press, and then we went out in the yard and got a long piece of timber and drove the die bed and bolster out from under the punch by main force. It was hard work, but it did the business, and I know of no better way to do it when a press is stuck just back of the center as this one was.

It was about 10 o'clock when we got through, and as we went out I said to Bill," "The joke ain't quite as good as it was the last time the "Old Man" came through, is it?"

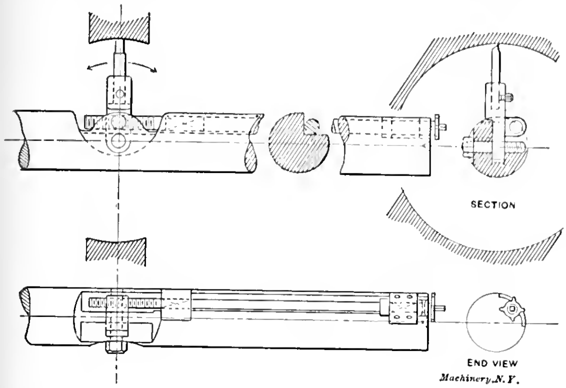
* * *

Not every wild statement of the daily press is as easily disproved as one published recently in a New York paper describing a new telegraph cipher code book which was claimed to contain 1,020,000,000 pronounceable words with at least two letters difference. In addition, it was claimed there were 160,000,000 extra words all arranged in alphabetical and terminational order, the whole being contained in one volume quarto size. The editor of the *Western Electrician*, being somewhat suspicious that this statement was not entirely within the bounds of truth, has done a little figuring, and tells us that allowing, say, 5,000 words to a page this volume must contain 236,000 pages, which would make a book over 39 feet thick—a truly ponderous tome!

LETTERS UPON PRACTICAL SUBJECTS.

A SPHERICAL BORING BAR.

The writer on his travels among the different shops happened on a very useful and interesting boring bar for boring spherical holes or rather ball-and-socket joints in pillow blocks, which, in his opinion, is hard to beat. The inclosed sketch is clear and needs no special explanation. This bar can be used either in a lathe or horizontal boring machine. The work of this bar, compared with that done on the vertical boring mill, is done better and more economically. The bar was seen in



Rig for Boring Spherical Surfaces.

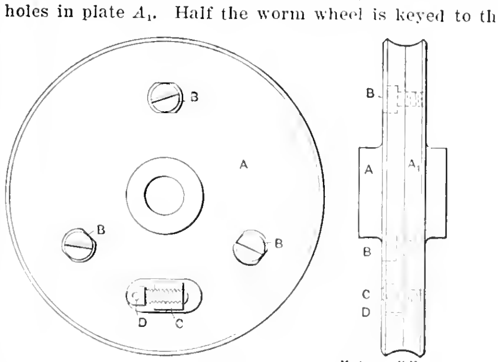
operation on a floor boring machine at the Geo. V. Cresson works, Philadelphia, and so far as the writer could learn, is only used in this shop and the Pelton Water Wheel Co.'s shop in San Francisco, Cal. It is simple and easily constructed. The toolholder swings on a pivot pin and is fed either way by the screw and nut, the nut being set in toolholder so as to accommodate itself to the screw as the holder moves back and forth. The feed screw is held in the slot by two bearings.

WARD.

[Our correspondent doubtless refers to specific construction when he says that this bar is used only in the two shops named. Spherical boring bars of slightly different form are in quite general use.—EDITOR.]

SPLIT WORM WHEEL.

The accompanying cut shows a split worm wheel which I think is of considerable interest to the readers of MACHINERY. It has 160 teeth and a pitch diameter of 10 1/16 inches, and a thickness of 1 3/16 inch. It is made of 2 plates, A A_1, 19/32 inch thick, which are held together by 3 fillister head screws, B, which go through slotted holes in plate A and into screw holes in plate A_1. Half the worm wheel is keyed to the



Worm Wheel with Adjustment for Wear.

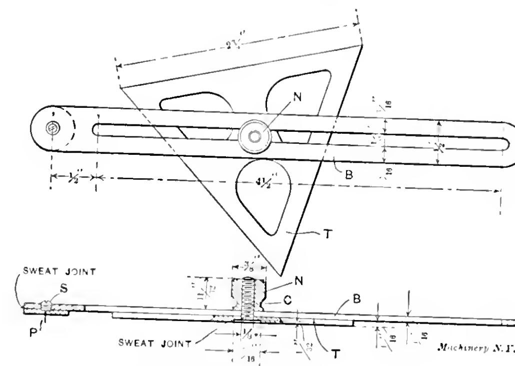
shaft and an adjusting screw, D, and stud, C, are provided for changing the relative position of the two halves of the wheel. The worm wheel is made in the usual manner, being put on a mandrel and hobbed out just the same as if of solid stock. The split feature is to take up the wear incident to use. When the teeth wear the screws are loosened and the adjusting screw is set up turning one plate by the other and thus taking up all the wear so that there is no back-lash with the worm. In this way it can be used until the worm is nearly worn out, still having no back-lash. This type of worm wheel is used in a cam cutting machine for sewing machine work where back lash must not exist, and the action must be perfectly smooth.

G. E. H.

TOOL FOR LAYING OUT RATCHET TEETH, TANGENTS, ETC.

The sketch shows a little instrument which I have found to be a great timesaver and aid in my work as draftsman and designer. Just where the little tool originated and whether or not it is on the market I am unable to say, but I have found it such a serviceable and desirable instrument that I know others will be glad to learn of it.

It is used in putting in both radial lines and tangents about a given center, as in drawing the teeth of a ratchet wheel, etc. The slotted bar, B, has a pin, P, held in one end of it by the screw, S; this pin is stuck into the paper at the given center, the triangle, T, is shifted lengthwise of the bar and turned



Tool for Drawing Radial and Tangent Lines.

about the screw, C, until one of its sides takes the direction of the radial or tangent which it is desired to repeat about the center. The triangle is then clamped firmly in position on the bar by means of the knurled nut, N, and then by swinging the entire instrument about the fixed pin, the edge of the triangle is brought to the successive positions at which it is desired to put in the required lines. The slotted bar, B, may be made longer than it is here shown, but for all of the work on which we use it, the length shown is sufficient.

Dayton, O. CLAUDE T. JOHNSON.

BRIGHTENING AND COLORING BRASS.

The work to be brightened and colored is first annealed in a red-hot muffle or over an open fire, allowing the cooling to extend over one hour, the object of the heating being to remove the grease or dirt that may have accumulated during the process of fitting. Soft soldered work, however, must be annealed before being fitted together, and afterward boiled in a potash lye. This is also done with work having ornamental surfaces. Next it is immersed in a bath of diluted oil of vitriol or aquafortis, either of which may be made with two or three parts of water and one of acid, but the old acid that contains a small quantity of copper in solution is frequently preferred. The work is allowed to remain in this liquid for one or two hours, according to the strength of the acid. It is then well rinsed in water and scoured with sand, which is applied with an ordinary scrubbing brush, and washed. The pickling bath is made by dissolving 1 part of zinc in 3 parts of nitric acid of 36 degrees, Baume, in a porcelain vessel and adding a mixture of 8 parts of nitric acid and 8 parts of oil of vitriol. Heat is then applied and when the liquid is boiling the work is plunged into it for half a minute or until the violent development of the nitrous vapor ceases and the surface is getting uniform. Then it is plunged into clean water

and well rinsed to remove the acid. The ordinary dark grayish yellow tint which is thus often produced is removed on immersing the work again in aquafortis for a very short time. Then it is plunged into clean and slightly alkaline water, well rinsed to remove the acid and plunged into warm, dry beech or boxwood sawdust, and rubbed until quite dry. To prevent the action of the atmosphere it is lacquered; if a green tint is to be produced, the lacquer is colored with turmeric. A dark grayish but agreeable tint is obtained by immersing the work previously in a solution of white arsenic in hydrochloric acid, or in a solution of bichloride of platinum with a small addition of some vinegar, or rubbing with plumbago.

Rochester, N. Y. JOSEPH M. STABEL.

BORDER LINE PEN.

The accompanying line cut and halftone illustrate a very clear arrangement of a border line pen, which to my mind is the cheapest and most simple scheme that I have ever seen. It is made by taking any old ruling pen, particularly one un-

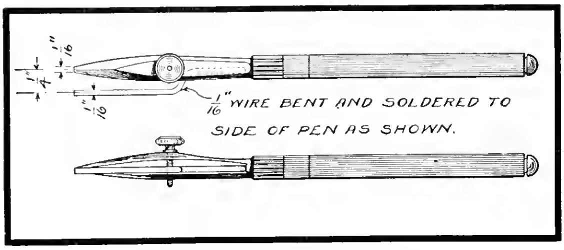


Fig. 1. Drawing Pen for Wide Lines.

fitted for further use and fitting a piece of steel or spring brass wire in the middle of the pen and soldering it to the fixed half of the pen; then both pen and wire are ground off until the former is of whatever standard width line you may wish, preferably one-sixteenth inch. Then smooth the points on an oilstone by holding the pen perpendicular, as shown in Fig. 2.

By having a pen of this kind in every drawing room a uniform width of border line is fixed. The advantage of

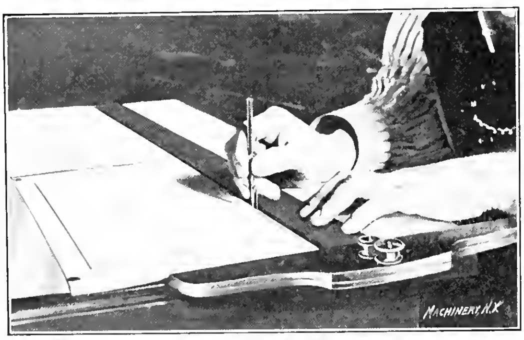


Fig. 2. Method of Using Pen.

uniform border lines on all tracings is apparent, especially when you know draftsmen who, when left to their own judgment have made them as wide as ¼ inch.

Fig. 2 shows the manner of holding the pen while using; the pen is held perpendicular and with the wire against the T-square, which not only allows the draftsman to see what he is doing, but also prevents the ink from running under the edge of the T-square.

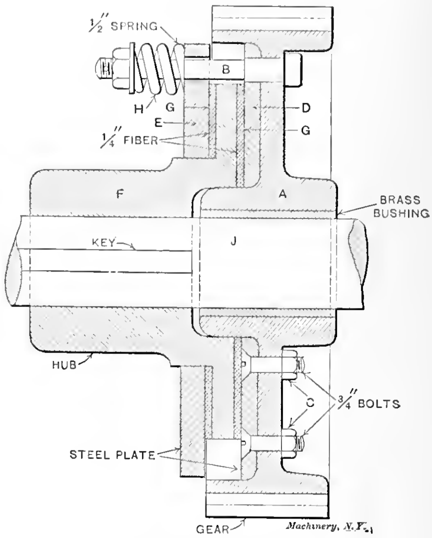
The border around Fig. 1 was made by the pen I use right along. ALBERT P. SHARP.

Williamsport, Pa.

[The cut, Fig. 1, is a photographic reproduction of a drawing made by Mr. Sharp, the original being 6 inches long.—EDITOR.]

IMPROVISED SLIP GEAR.

The accompanying cut shows an ordinary spur gear after having been transformed into a friction or "slip" gear to prevent breakages. The gear is used on the inspection bed pull-up of a large structural steel mill to drive a drum on which is wound a cable. This cable in turn drags the I-beam channels or other product of the rolls to one end of the inspection bed by means of dogs, the product sliding on rails or skids. Owing to carelessness on the part of the operator in not stopping the motor in time to prevent the collision of the beams pulled up with others already at the end of the bed the gears were broken quite frequently, so it was determined to provide means for slippage to prevent these breakages. As the gears were steel castings and a supply of them was on hand it was decided to convert them into slip gears, which was done in the following manner:



Friction Slip Gear used to Prevent Breakages.

The web, rim and hub of the gear were machined on one side, and a ¾-inch steel plate *D* was turned to fit. This plate was bolted onto the gear with 8 countersunk bolts, *C*. Eight steel pins, *B*, with nuts and split cotters were fitted through the web and plate, projecting on the machined side of the gear so as to make space for the coiled springs, *H*. A hub, *F*, with a turned flange, was made and fitted over the end of the gear hub, which latter had previously been bored out and bushed with a brass bushing; the hub *F* was keyed to the shaft *J*. Another steel plate, *E*, 1¼ inch thick, was bored out to a sliding fit over the new hub, this plate having holes drilled to correspond with the 8 pins in the web of the gear, the holes being a loose fit for the pins. A ¼-inch fiber disk was put between the hub flange and the steel plates on either side to form wearing surfaces. Springs made of ½-inch wire were put on the pins and tightened to the required pressure. The new hub was keyed to the shaft, thus making practically a "fool-proof" arrangement, as the master mechanic of the mill expressed it. Whether it answers this description or not, we know that we have had no further trouble with broken gears since. BESSEMER.

WHAT THE BRASS CHECKS SAY.

By looking over the brass check board in the tool room we often find that certain checks stick to their respective hooks as if they were melted together. Upon asking the tool-room keeper about those checks we may be sure to get something like the following answer: "That's a lazy fellow—'Old Bill'; he don't care about returning tools." But "Old Bill" cares more than it seems. He simply looks after his own interest and at the same time after that of the company. Further investigation shows that Bill has a hacksaw, ratchet wrench, two sets of taps, etc., the most of which he has had in his possession for about a quarter of a year, and seems to have forgotten about returning same. At the same time Bill's neighbor on the bench comes along returning a tool with the words "that's no good" and, dissatisfied, goes back to his work. Bill working not far away hears his re-

mark and smiles. Why? Well, he has got the best hacksaw there is in the whole toolroom, and a lot of other first-class tools from the toolroom. The rule says that a tool should be returned as soon as the job is finished, but can you blame Bill for not doing so? Very likely not. But who is to blame that his fellow workmen don't get a chance of using these tools? No one else but the toolroom foreman for not inspecting the tools from time to time. If he would attend to his duty and have the tools fixed up, sharpened, ground, adjusted as they ought to be, there would be no complaint about a tool not being satisfactory, and no workman would keep the real good ones in his tool-chest. By doing as above, the foreman would help the company and the workmen to make more money, because everybody knows that working with a first-class tool saves time, and time saved is money saved. This is the story the seemingly forgotten brass checks tell, if we only want to listen to them. GEORGE WILLIAM BOEHLER.

Forrest Hill, Mass.

BORING BAR CUTTERS.

The proper interchangeable flat cutter for horing bars is a subject of more or less general interest. Upon visiting quite a number of different shops as many kinds of boring bars with inserted or attached cutters may be found, with the exception that the majority of ordinary bars will have the cutters held in by a drive wedge or key. In some shops a set screw is used. Neither of these holds the cutter securely without undue strain, which is apt to, and very often does, spring the bar out of true.

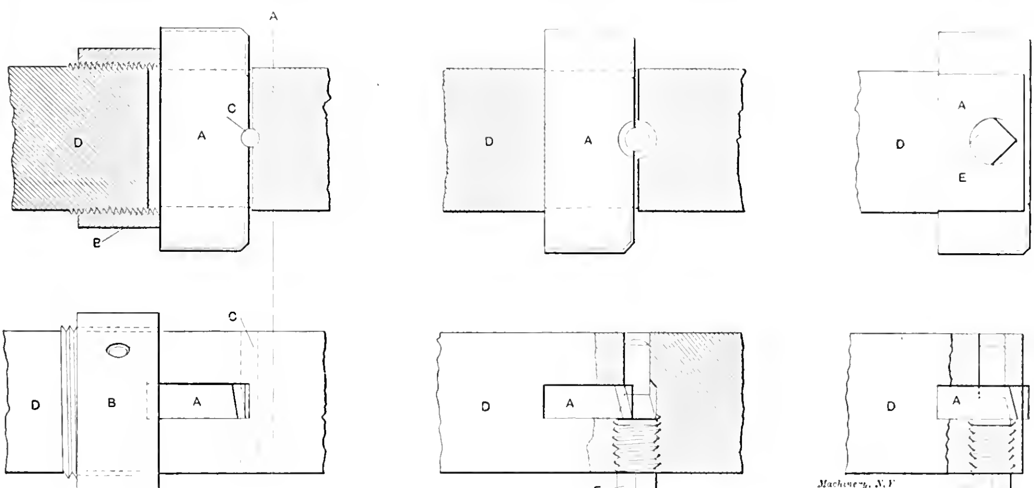


Fig 1. Fig 2. Fig 3.

Fig. 1 shows a method of holding cutters, which although not new, is not generally known nor used on boring bars and counterbores as much as it should be, being well adapted to general use. Cutter A is centered by pin C and clamped by collar B, which screws on bar D, the thread being right- or left-hand, as may best suit the work. Fine thread should be used. Line A A represents end of bar when it is desired to use this form for chucking work or end boring.

Fig. 2 shows a method of holding a flat cutter by a single screw E; this screw both locates and secures the cutter A. It affords a simple and handy means of holding flat cutters set central; and fly-cutters are easily held so they can be adjusted by making the cutter enough narrower than the length of slot to allow for a gib under the side of the screw. The gib should have a half-hole same as cutter shown to prevent crawling when tightening the screw.

Fig. 3 shows the same cutters as Fig. 2 used in the end of a bar for use on boring mills and chucking work of general character. As is shown, this construction allows the cutter to project beyond the end of the bar, thus making it useful in squaring the bottom of a hole or boring to a shoulder. This method is also used for counterbores by adding a pilot on the end of the bar. On all cutters of this kind the best general proportions are: Thickness equals ¼ diameter of bar, plus 1/32 inch; width equals 2/3 diameter of bar. M. S. W.

HARDENING TRANSMISSION CHAIN PINS.

In the manufacture of transmission chains it is now customary to harden the different parts before assembling, to avoid, as far as possible, the lengthening of the chain by wear. It was found to be a simple matter to harden the blocks, or rollers, as the case might be, but to properly harden the pins or studs was a horse of a different color, so to speak. The conditions confronting the manufacturer were, that the body or bearing portion of the stud must be hard while the reduced ends outside the shoulders must remain soft enough to rivet, as indicated in Fig. 1. To these unusual conditions was added still another, namely, that the process must be comparatively cheap. Upon investigation there were found to be a number of different ways by which the desired result might be accomplished. Which particular way was finally decided upon I cannot say, as I was not present; but my way, which is good enough for me, is as follows:

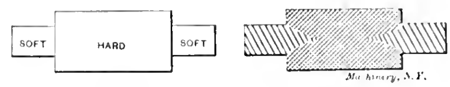


Fig. 1. Fig. 2.
Pins with Hard Centers and Soft Ends.

The studs are first produced in the usual manner, by automatic screw machines, from dead soft crucible steel wire. After cleaning they are thrown into the revolving hopper of an automatic electric heating machine, which is operated by a cam-shaft geared five to one with the driving pulley and carrying the necessary number of cams to operate the mechanism. A tubular collecting arm, or trough, the end of which dips at regular intervals into the horizontally revolving hopper, collects the studs and deposits them by the return tip of the arm into the top of a short vertical tube where they stand end to end in a solid column. Next an arm carrying spring fingers at its outer end swings back and forth between the lower part of the vertical tube where one stud at a time is exposed to the clamping dies, which clamp the studs endways as they are presented between them by the spring fingers of the carrying arm. Now these clamping dies are the terminals through which a current of 10 volts and 500 amperes flows, and is timed by a cam actuated make-and-break contact after the clamping dies have the stud clamped firmly between them. After being brought to the proper heat, which is almost instantly, the dies open and the current is shut off simultaneously and the hot studs are dropped into a tank containing a solution of salt and water. The result of this treatment is

that the ends of the stud, being clamped endways between the cool faces of the dies, which are large enough to carry the current without heating, are necessarily too cold to harden, while the body of the stud between the shoulders, being further away from the cold dies, receives a hardening heat as indicated in Fig. 2. The darker portion of cut shows the hard part and the lighter portions the soft ends.

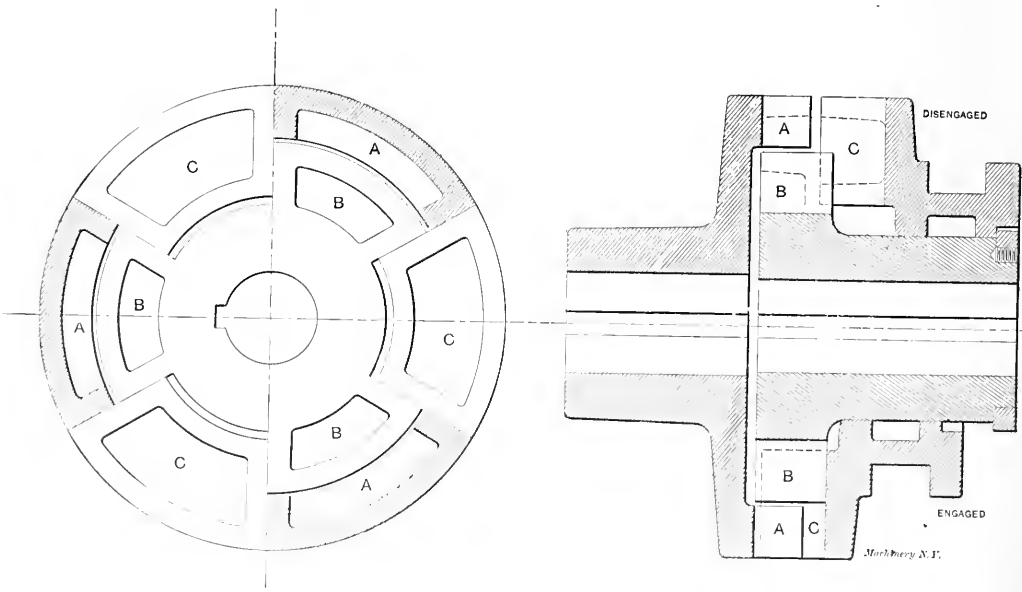
The capacity of the machine is fifteen hundred studs per hour, and it requires but very little attention. BRISTOL.

[The foregoing described method of annealing the ends of chain studs is practically the converse practice of that of one well-known chain-making concern. The practice of this concern is to heat the pins in a furnace and to harden them by dipping in a bath in the usual manner, and then to anneal the ends by an electrical process by which carbon electrodes in contact with the ends of the pins, raise them to a red heat so quickly that the body of the pin is not affected. In this way the hardness of the body is not changed while the ends of the pins are softened sufficiently to admit of riveting over.—EDITOR.]

A TOOTHED CLUTCH.

A great inconvenience connected with the tooth-clutch in common use is the necessity of having one of the two parts—advantageously the driven one—sliding on the shaft, in order to disengage the clutch. This lack of a firm connection between clutch, key and shaft results in a tendency to turn the key out of its bearing and, when disengaging is done under full pressure, as is generally the case, in a wearing off of the sides of the key. The application of two keys lessens this inconvenience, but does not abolish it. The accompanying illustration shows a tooth-clutch which avoids the sliding on the key, having both parts, the driving part *A* as well as the driven part *B*, firmly keyed to the shaft, while the engaging between the two parts is performed by a third part *C*, which slides on the hub of *B*, but cannot revolve around *B*. The upper half of the illustration shows the clutch disengaged, the lower half engaged. As can easily be seen, the teeth on the driving part *A* are arranged on a larger circle than those in the driven part *B*, so that part *A* may freely revolve around *B*, while the teeth on the third part *C* slide in between those of both *A* and *B*. As soon as *C* is shifted toward *A*, the teeth of *A* and *B* are connected by those of *C* and the power is transmitted to the driven shaft. Thus the hub of the sliding part *C* has nothing to do with the transmission of power and motion, and serves only to shift the teeth into proper position.

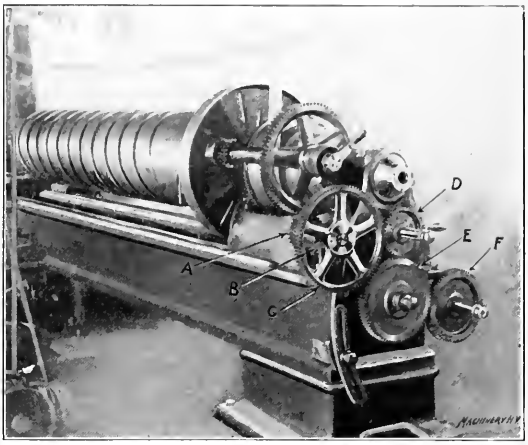
Philadelphia, Pa. ALBERT GOTTSCHALK.



Tooth Clutch with both Driving and Driven Members Keyed Securely to Shaft.

HOW A COARSE PITCH SCREW WAS CUT.

The accompanying photograph shows a Fay & Scott standard 32-inch lathe geared to cut a 16-inch pitch thread. A lathe of this size would hardly be expected to cut as coarse a thread as this with the ordinary method of change gears. It was accomplished in the following manner:



Lathe Geared for Cutting Coarse Pitch Screw.

The ratio of back gears on this lathe was 12.564 to 1. That is, one revolution of the spindle required 12.564 revolutions of the head cone. The pitch of the lead screw was one inch. To get a feed to the carriage then of 16 inches would require that the screw make 16 revolutions to one revolution of the spindle, or 12.564 revolutions of the cone.

B is a bearing bolted to the bed of the lathe carrying an intermediate shaft, on which was mounted gears *A* and *C*. Gear *A* meshed into the regular back gear which simply served as an intermediate between the cone pinion and *A*. Gears *D* and *E* are intermediates, *D* being a regular change gear on the headstock intermediate spindle. These two intermediates were required for cutting left-hand threads. When a right-hand thread was being cut the gear *D* was removed, and *E* brought up into mesh with *C* and *F*. The gearing arrangement then was as follows:

Let the cone pinion be represented by *G*.

Then revolutions of cone pinion $\frac{G}{A} \times \frac{C}{F}$ = revolutions of

the screw, or $12.564 \times \frac{26}{27} \times \frac{92}{69} = 16.1$, which was near enough to the desired result. With this arrangement the lathe had ample power for cutting this coarse thread.

The thread in question was cut on a steel roll 20 inches diameter by 10 feet in length. These were double square threads 1 inch wide by 1/4 inch deep. Into these grooves were wound cold-rolled steel 1 × 5/8 inch. This steel was wound in cold by means of rolls arranged on the tool block, and it had to be fastened with screws at every 18 inches to keep it from springing out of place. The rolls were for use on a patent log hauler for winter use designed to screw its way through the snow, and take the place of the traction engine. These screws were manufactured at the works of Fay & Scott, Dexter, Me. W. L. FAY.

Dexter, Me.

THE EVOLUTION OF A CUTTER TO REDUCE TOOL-MAKING COST.

In making a cast-iron slide having concave and convex cuts high-speed steel milling cutters were adopted to reduce manufacturing cost. The cost of making the cutters for a lot of slides was considered to be quite an item, hence the change in the design of the cutters to reduce the tool-making expense. The cuts, Figs. 1, 2, 3 and 4, illustrate the evolution of the cutter to the present form in order to make the cost of maintenance as low as possible. The design of the slide required a certain diameter, form and length of cutter, proportions of which are indicated in the cuts.


Fig. 1

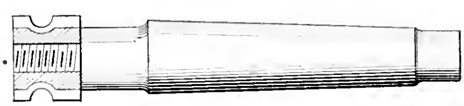


Fig. 2


Fig. 3


Fig. 4


Fig. 5

Different Methods of Cutter Construction

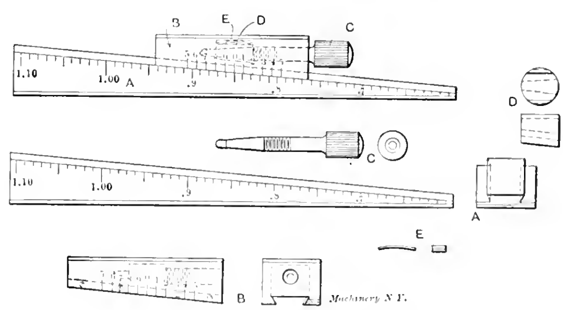
Fig. 1 illustrates the first cutter made and it is the most expensive, being solid, which required the grinding of the shank end as well as the cutter end after hardening; the cost of the steel (Novo), turning, milling the teeth, hardening and grinding, made the cost of this cutter quite high. In Fig. 2 the objection to the construction is the difficulty of releasing the cutter from the arbor and the liability of springing the threaded end, which is weak, because of the reduction of area due to cutting the thread. The cutter shown in Fig. 3 was made with a rod through the shank and a nut at the small end of the shank to draw the cutter up tightly against the shank, and to release it readily without springing; the objection to this design is the changing of the thread in the cutter in the hardening process, and this trouble also occurred in Fig. 2. Fig. 4 shows how these faults were corrected by making the cutter with a keyway or spline, and fitting it on a reduced diameter of the shank itself. The bolt is made with a thin head and the nut at the opposite end is made with a cap to protect the thread when knocking the cutter out of the spindle. The bore in the cutter is lapped to fit the arbor closely.

The convex cutter is shown in Fig. 5, and its construction is similar to Fig. 4, with the exception that it has a taper hole and rod to fit. A slot is milled for the tongue or key on the arbor as indicated by the dotted circular line with a saw 1 inch in diameter and 1-16-inch thick. The rod should be a close fit at the cutter end to insure a rigid support. The hole being tapered in the cutter there is no need of lapping, as is the case in Fig. 4. A. C. LINDHOLM.

Prince Bay, S. I.

PARALLEL VERNIER GAGE.

The cut shows a parallel vernier gage that has proven to be very handy in measuring when lapping and milling snap gages; it can also be used as a small height gage to measure the distance from a shoulder to the base on planer or milling machine work. After a snap gage has been ground or lapped in a machine to within, say, 0.0005 inch it must be hand-lapped, for a slight tipping to one side or the other is bound to occur in the machine and as a consequence the surface becomes belly-shaped. The tool illustrated is used in connection with the lapping in order to get perfectly straight and parallel surfaces. It has a rise of 1/2 inch in its length from 0.600 to 1.100 inch, and it may be used for any greater height by fastening half-inch blocks on top of the slide with screws. If such blocks are used they must be hardened, ground and lapped true. The slide B is made of tool steel and is composed of two pieces. The top plate is hardened and ground and soldered on. Four small screws hold the gibs in position and provide adjustment; the tapered knurled screw C serves to lock the top slide at any point on the base A by lifting the binder D which is slotted on the under side to fit the dovetail on A. The flat spring E is placed in the top of the hole in B in order to push the bushing down clear of the dovetail A so that the slide B may move freely when released. A 1-32-inch hardened sheet steel plate is also soldered onto the bottom of the base A, thus forming hardened working surfaces on top and bottom. The tool is ground square and parallel all over, and the top and bottom are lapped, care being taken to have the sliding parts scraped straight in order that the measurements will register correctly for all settings.



Toolmakers' Depth or Width Gage

When it is finished and assembled, the graduations should be marked. This can only be done by hand. Mark the slide B in the center with a zero line and locate it at 0.600, 0.700, 0.800, etc., positions on the base by using a micrometer, and mark each position with a line and the proper figures as shown in the cut. Then divide each space into ten equal parts. To make the vernier the top scale must be laid off so that ten spaces cover the distance of eleven on the lower scale, 5 1/2 of the divisions on the lower scale being on each side of the zero line when set as shown in the cut. The divisions on the vernier should be numbered from 1 to 5 on the right-hand side and from 5 to 9 on the left-hand side of the zero mark. It

will thus read in tenths, hundredths and thousandths. The graduation of the instrument is similar to that of vernier callipers and is read in the same way, but is much plainer on account of the places being wider; in the position shown the gage reads 0.850 inch. If one, or more thousandths, is wanted move the slide along until 1, 2, 3, etc., meet the corresponding lines on the bottom scale.

Under no circumstances should this tool be hardened, as it will warp so that it is impossible to lap it straight. This is the reason that the hardened steel plates are soldered on top and bottom so as to give it a hard surface on the principal wearing parts. O. WESTBERG.

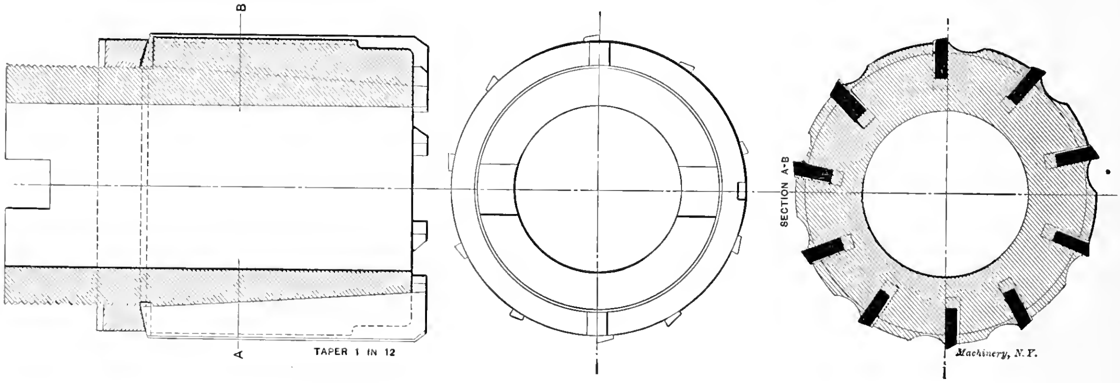
CUTTERS OF COLD-ROLLED STEEL.

Herewith you will find a blueprint of an adjustable reamer such as used by the Jones & Laughlin Steel Co., for reaming the bore of pulleys, etc. The cutters of these reamers are of common cold-rolled steel, case-hardened, and give as good service as ones formerly made of the more expensive grades of steel. The formula used for case-hardening is as follows:

Use Rogers & Hubbard Co.'s (Middletown, Conn.) No. 2 granulated raw bone; pack the cold-rolled steel in cast iron box with one-half inch layer of raw bone all around; cover box and close up with fiber clay. Heat in a gas furnace at almost white heat for from two to five hours; draw the steel, and dip quickly in the following mixture:

One quart of vitriol, 4 pecks of common salt, 2 pounds of saltpeter, 8 pounds of alum, 1 pound of prussiate of potash, and 1 pound of cyanide of potash. Dissolve this in 40 gallons of soft water. Care should be taken not to breathe the fumes coming from the cyanide of potash, as they are very poisonous. F. WACKERMANN.

South Pittsburg, Pa.



Cutters with Inserted Teeth of Cold-rolled Steel.

MAKING TIN TUBES.

The brooder and incubator trade calls for a large number of tin tubes, usually of 1 inch diameter, about 4 inches long and folded on one or both ends. Several requests have come in for information on the making of these tubes, and this is sent you with the sketches to satisfy that demand.

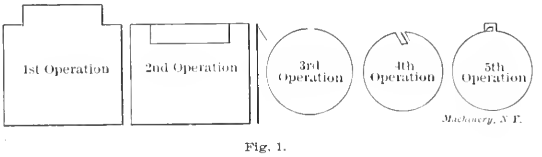
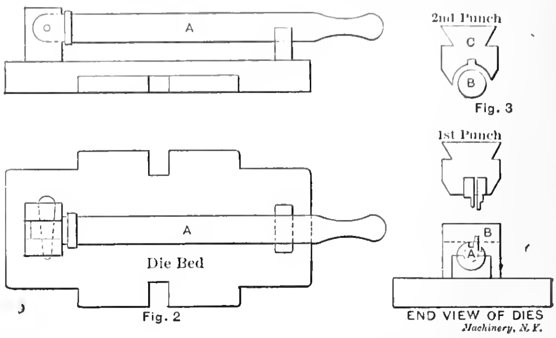


Fig. 1.

The blank is usually cut out as shown in the first operation, Fig. 1, the corners being cut away to allow for the folding process which is shown in the second operation, and the tube is then rolled to the shape shown in the third operation.

While these three operations can easily be made with press tools, unless the quantity wanted is very large, there is a saving on the tool-making end by making them with an ordinary tinsmith's outfit. The fourth operation, bending the lock is done on the die shown in Fig. 2. The tube is slipped on the mandrel *A*, each edge of the tin being forced up against the stop *B*, and one stroke of the press forms both ends into the shape shown by the fourth operation in Fig. 1.

The tools shown in Fig. 3 are for the fifth and last operation. The tube can be formed with the seam on the inside or



on the outside by making the necessary change in the arbor and closing punch. While the tools can be used in any ordinary power press, the best results can be obtained in a short-stroke foot press, as the work can be handled to better advantage and the cost of the dies is less. These tubes cannot be drawn from tin as it is difficult to draw the depth more than equal to the diameter of the tube. A good grade of tin will stand two drawings, and in exceptional cases, three; but that would be too short to give the desired length in this case.

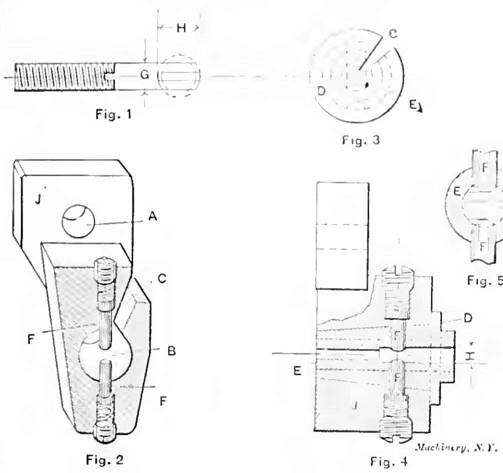
Bridgeport, Conn. J. L. LUCAS.

LOCATING DEVICE FOR SCREW SLOTTING ATTACHMENT.

Having had many years experience of a more or less difficult nature in the capacity of foreman of a large hand and automatic screw machine department, there have been times when the conditions connected with certain work required the working out of new ideas, which, when put into practice, simplified matters considerably in manufacturing certain parts. Such little devices, in this or other shops, receive no notice outside of the place in which they have their origin, even though many factories throughout the country might have similar conditions to deal with. I would like to call the attention of the readers of MACHINERY to a device for locating work having flat sides, in the holder of the screw slotting attachment used on the Brown & Sharpe automatic screw machine. I have used the attachment about to be explained for the past ten months with excellent results and can therefore vouch for its efficiency.

I have at present two automatic machines making screws of flat stock, which, as shown in Fig. 1, have to be slotted parallel with the flats. A sketch of the attachment to which I desire to call attention is shown, enlarged, in Fig. 2. This illustrates the device as completed, but represents it with the

face milled off, as shown by the section lining, on a vertical plane through the center line of the screws and spring plungers; an axial section is shown in Fig. 4. The hole *A* is for the screw which fastens the holder to the arm of the slotting attachment. The hole at *B* is for the bushing which holds the screw while it is being slotted. This hole is made tapered to fit the bushing which is shown at *D* in Fig. 4 and in end view in Fig. 3. Slot *C*, which is shown in both Figs. 2 and 3, is cut the full length of the bushing and permits the passage of the ejector or stationary blade which pushes the finished work out when the slotting arm with the holder and bushing attached drops back from the saw. Bushing *D* may be made



Locating Device used in Slotting Flat-sided Screws.

from the regular one furnished with the attachment, internal bushing *E* being driven into it to fit it to this particular job. Holes for the plungers *F F* have also to be drilled.

In Fig. 4 is shown a cross section of the holder with the bushings inserted and the parts in the position they occupy when the holder is empty. Spring plungers *F* are pressed by the springs on their heads to the full depth of the counterbore in which the heads are seated, leaving a space between their points a little less than the width *G* of the screw shown enlarged in Fig. 1. The diameter of the hole *H* is about 0.001 inch larger than the same dimension on the screw. The depth

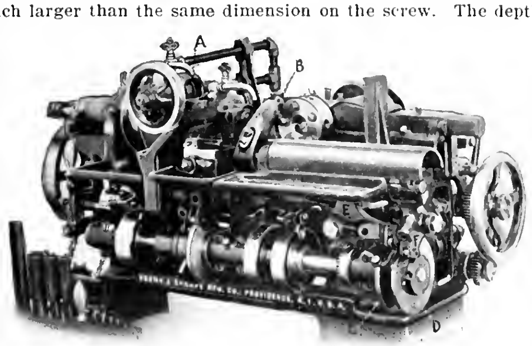


Fig. 6. Brown & Sharpe Automatic Screw Machine with Screw Slotting Attachment.

of this hole is sufficient to allow the head of the screw to project a slight distance further than the depth of the slot beyond the bushing.

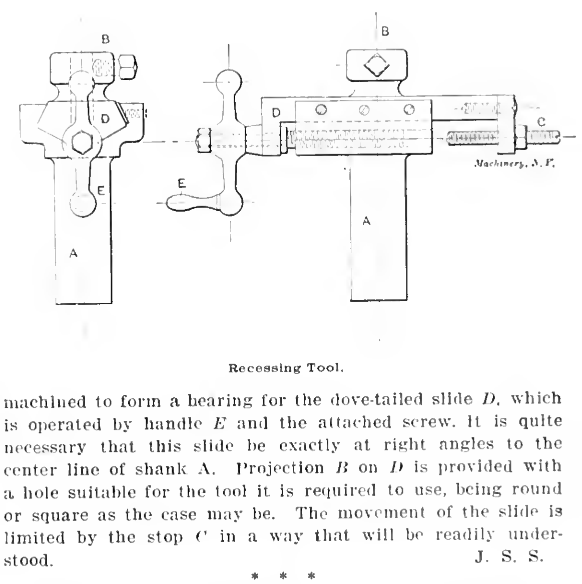
In operation the holder *J*, with its bushing *D*, is pushed over the work as it revolves in the chuck just before it is severed from the stock. As the piece revolves, plungers *F* ride over the contour of the work, rising as they pass the full diameter and coming together at the flats. When a piece is almost cut off, the tension on the two studs will be sufficient to break it from the stock and hold it in position by the two flats as shown in Fig. 5. The work is then in position to be slotted with a cut parallel to the flat sides. PHILIP STERN.

Hartford, Conn.

[Perhaps the accompanying halftone and description will show more clearly the slotting attachment referred to and lead to a better understanding of the device described by Mr. Stern. In Fig. 6 is shown a Brown & Sharpe automatic screw machine with slotting attachment. The saw is shown at *A* and this is driven by an independent round belt from the countershaft above. Arm *B* carries the holder shown in Fig. 2 with its bushing, Fig. 3, for holding the work. This arm has two movements, a reciprocating motion lengthwise of the machine and a swinging motion about its longitudinal axis as a center. These two movements are controlled by cams *C* and *D* respectively. As the work is about to be severed by the cutting-off tool, arm *B* is swung down by the cams until the bushing Fig. 3 is in line with the spindle. It is then advanced to encircle the work. Immediately after the severing of the screw by the cutting-off tool, arm *B* is swung upwards by cam *D* until the screw which it carries is in line with slotting saw *A*. Cam *C* then again comes into play and feeds the screw up to the saw and slots it. The arm and bushing are then dropped back, during which action an ejector passes through slot *C*, shown in Figs. 2 and 3, thus pushing the completed screw out of the bushing. While this slotting has been going on the main turret has, of course, been at work on a new piece, which is received in turn by the arm *B* and carried to the slotting saw.—EDITOR.]

RECESSING TOOL FOR SCREW MACHINE.

I show herewith a sketch for a recessing tool for a screw machine or turret lathe. This device has a wide field and can be used for recessing, or for cutting a groove in a hole of any size, as well as for boring or squaring up a piece in a chuck where it is necessary to use the back and front cross slide tools for other purposes; altogether I find it a very satisfactory tool to use. *A* is a shank fitted to the hole in the turret of the screw machine. The front end of this piece is



Recessing Tool.

machined to form a bearing for the dove-tailed slide *D*, which is operated by handle *E* and the attached screw. It is quite necessary that this slide be exactly at right angles to the center line of shank A. Projection *B* on *D* is provided with a hole suitable for the tool it is required to use, being round or square as the case may be. The movement of the slide is limited by the stop *C* in a way that will be readily understood. J. S. S.

* * *

The economy of the steam engine is much enhanced with superheated steam and happily the use of superheated steam with the steam turbine is much more practicable than with reciprocating engines. One reason for the superior efficiency of superheated steam aside from purely thermodynamic cause is the lessened retardation of the wheel due to loading with condensation. Prof. Thurston pointed out a number of years ago that the energy absorbed by a single drop of water falling on the periphery of a turbine wheel 10 feet diameter running at 500 revolutions per minute amounts to 67.7 foot-pounds; with saturated steam, the condensation may be as high as 20 per cent., hence the loss from mechanical retardation alone might be a very important item in turbine economy, although not as great as indicated above, for improved turbines do not run at any such peripheral speed as 15,700 feet per minute.

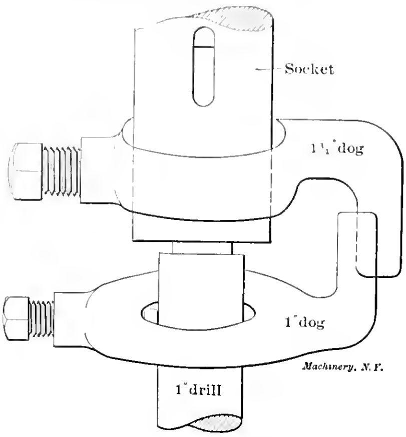
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

EXTEMPORIZED DRIVER FOR TWIST DRILL.

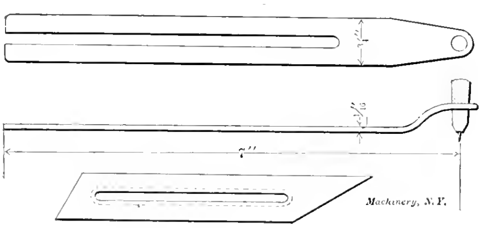
One of our apprentices twisted off the tang of a 1-inch twist drill the other day; and it being the only 1-inch drill on hand, and as he had quite a few more holes to drill he had to use the drill as best he could. He had a hard time of it at first,

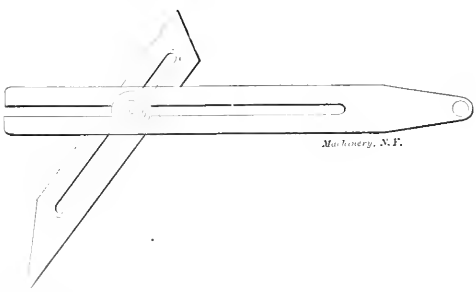


for no matter how hard he drove the drill in, it would turn round in the socket until "Old Pop Deming" took pity on him and helped him out. The sketch shows how "Pop" helped him out, and it needs no explanation. It may be of service to apprentices who read MACHINERY. C. F. EMERSON.

DRAFTING TOOL FOR SKETCHING RATCHET TEETH, ETC.

The sketches show an extremely useful little drafting tool which any mechanic can make in a short time. I used the slotted blade from a Starrett universal bevel (the blade which has the ends beveled to 30 and 60 degrees), also the clamping screw and nut. The other part is made from a piece of ¾ x 1-16-inch cold-rolled steel and a piece of ¼-inch drill rod.





It is used for drawing ratchet teeth or any similar work. If one has the time, a chuck or clamping device for holding a needle point might be made instead of the solid stem and point shown. The bevel, without this attachment, is quite handy in drawing as well as machine work. The device is not patented and some manufacturer might take a hint for the combination would be useful to any draftsman.

HANDYMAN.

PICKING UP SMALL ARTICLES WITH TWEEZERS.

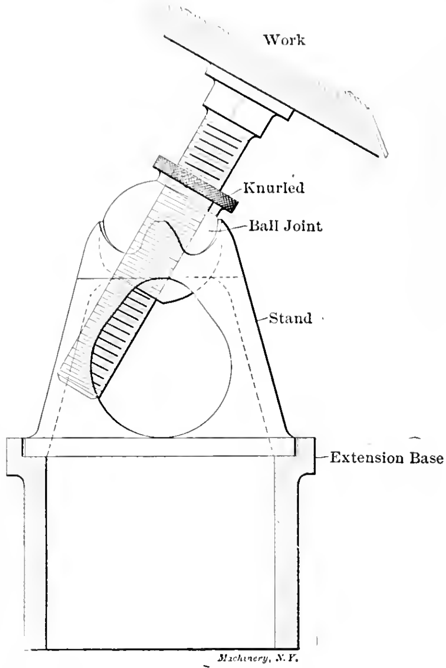
It often happens, in handling small pieces, such as screws and pivots, that the tweezers slip, because they have not a good grip. This may be got around by laying the object on the back of the hand—as being cleaner than the palm—and then picking it up. In this case the tool has a deeper grip on the object than where it must be picked up from the table or work-bench. If you don't believe it, try it.

It is singular, but I have never yet found a workman who had got on to this Columbus-egg-like trick.

Hannover, Germany. ROBERT GRIMSHAW.

JACKSCREW WITH EXTENSION BASE.

The sketch shows a convenient jackscrew which is easily adjusted to suit castings that are to be machined. The exten-

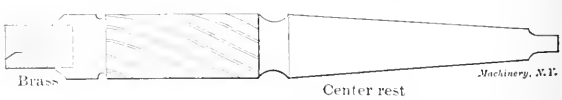


sion base shown can be built to suit the work, or two or three may be placed one on top of the other as the case may require.

I. N. QUIRE.

GRINDING A COMBINATION FLAT DRILL AND MILL.

Some time ago I made some special combination flat drills, and mills, for drilling and milling elongated slots in brass tubing. When the mills became dull, it was a serious problem to sharpen them and sharpen them concentric, as the original center, on the point of the drill, had been ground off, when the drills were groud. After everybody had had a



whack at the job without success, I came to the conclusion that the only way to grind them was to put a fake center on the point of the drill. This was done by taking a piece of brass and slotting the end part way, to straddle the flat of the drill, after which the mill and brass, were gently heated, and undiluted shellac applied. The mill is afterward recentered in the usual way, on the center rest. In grinding care must be taken not to hammer, or heat the mill as the brass plug is very easily separated therefrom. Shellac melts at about 190 deg. F., so there is no danger of drawing the temper of the tool. When the grinding is completed a slight tap on the brass plug separates it from the mill, which is then ready for use. FRANK G. STERLING.

Lowell, Mass.

TURRET KNURLING TOOL.

Fig. 1 shows a top view of a turret knurling tool complete and Fig. 2 a side view, while Figs. 3 and 4 are side and top details of the turret part, which is made of tool steel. Fig. 3 shows three sets of knurls, Nos. 1, 2 and 3, which are fine, medium and coarse, respectively. Each pair is made right and left-hand. They are mounted on 1/4-inch Stubbs steel-hardened pins, C. In ordinary use the work rotates at E, E_1 or E_2, the selection of position being made for fine, medium

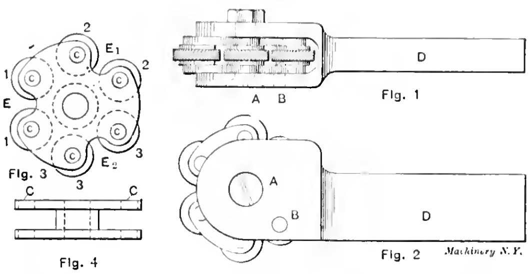


Fig. 3 Fig. 4 Fig. 1 Fig. 2

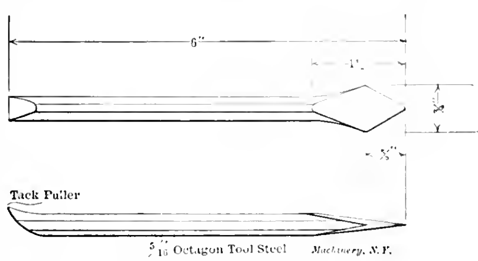
and coarse knurling as required. Where a simple spiral corrugation is wanted a single knurl may be used by locking the turret, and this is done by partly pushing out one of the pins C through the hole B, shown in Fig. 2, thus locking the turret in position so that a single knurl may be used. Ordinarily the turret carrying the knurls floats so that it automatically adjusts itself to the height of the rotating work. The turret part is mounted on a 5-16-inch countersunk hardened tool-steel screw, A, with nut.

C. C. Arras.

Buffalo, N. Y.

INK ERASER AND THUMB TACK PULLER.

I have read with interest the contributions telling how to remove ink from tracings, etc., and show sketch herewith of an ink scratcher which is in use in our drafting room. We use the scratcher to scrape off the heavy black lines, and then clean the rest off with a Faber's typewriter eraser, after which the erased surface is rubbed down with a soapstone pencil.



By doing this carefully the same place can be erased several times without cutting a hole in the tracing. It will be noted that the opposite end of the tool is formed into a claw for lifting tacks, thus making a convenient combination tool.

Torrington, Conn. E. C. Falk.

CASE HARDENING RING THREAD GAGES.

To harden ring thread gages without distortion anneal the gage after roughing out, and when finished cutting the thread, fill it with powdered cyanide and then heat up in a gas furnace, being very careful to exclude cold drafts as much as possible. When the heat has reached the right temperature turn the gas almost off and let the piece remain in the furnace for about ten minutes. Then dip in oil and keep moving around in a direction like the figure S. When cool enough, remove and clean with kerosene oil. I have hardened many gages this way and the maximum change observed was only ¼ thousandth in a half inch.

Everett Kneen.

Kearny, N. J.

THREADING OVERSIZE BOLTS WITH HAND DIES.

Here is a little kink that has saved me considerable hard work and strong language. I was working on a repair job a few years ago and had to thread a bolt with hand dies. As the iron was a trifle over-size and the dies were dull I had trouble in getting them to "take hold." I had begun to talk very plain to the bolt, the dies and the job in general when a friend asked me to let him show me how to start the dies on.

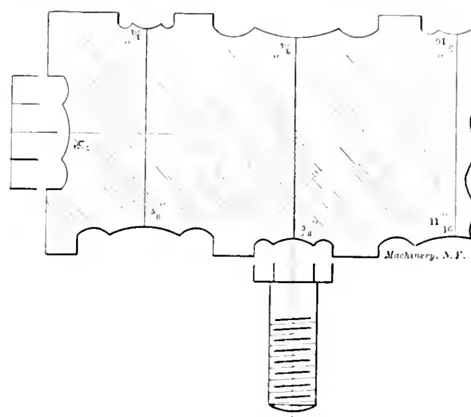
He took the bolt to the emery wheel and ground it so that it was nearly square on the end, as shown in the cut. The dies "took hold" without any further trouble.

I have since had occasion to use this kink a number of times and I trust it will save others considerable hard work.

Salem, O. Roy W. Harris.

TEMPLATE FOR DRAWING NUTS AND BOLT HEADS.

A very handy template for drawing nuts and bolt heads can be made as here shown. It is made of thin transparent celluloid and facilitates what is perhaps the most commonly repeated work to be done on a drawing. Lines are ruled on the template which, when used, are placed over the center



line on the drawing, and the curved outlines can then be drawn. The template can be made very readily by using the bow spring dividers which after repeated use will have cut into the celluloid enough to allow the pieces to be easily removed.

Winamac.

USING A METRIC TAPE AS A CIRCUMFERENCE RULE.

I accidentally discovered that the circumference tape, which gives the diameters in direct reading, has a rival in the metric tape. A centimeter is 0.3937 inch and $\frac{1}{8}\pi$ is 0.3927. Therefore, by measuring the circumference with a metric tape and reading the circumference in centimeters and converting same into eighths the diameter may be readily obtained in inches. For example, should the circumference measure 21 centimeters it is called 21 eighths, which equal 2 5/8 inches, or the diameter. By this method of measuring diameters an error of 0.001 inch is involved for each centimeter but this is usually close enough for work measured by a tape line.

I sometimes use a millimeter scale for laying out diametral pitch distances, as, for example, 8-pitch equals 10 millimeters, 5-pitch equals 16 millimeters, and so on.

Winamac.

* * *

In the early manufacture of scroll chucks the teeth on the back of the jaws for engaging the scroll were first made by a series of plain milling cuts and the corners were afterward rounded by filing. Mr. A. F. Cushman, of Hartford, Conn., it is claimed, first devised the method of cutting the teeth in the jaws with a scroll cutter. This cutter was made of the same pitch and form as the scroll with which the teeth were to engage and was provided with milling teeth, which cut out the stock as the jaws were fed past it. This process saved all filing and made a great improvement in the manufacture of scroll chucks.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

200. TO HARDEN DRILLS FOR CUTTING GLASS.

To harden drills for cutting glass, dissolve zinc in muriatic acid to saturation, then reduce the solution by adding an equal volume of water. Dip and use without tempering.

E. W. NORTON.

201. NON-RUSTING SOLDERING FLUID.

To prepare a soldering acid that will not rust iron, add to a saturated solution of zinc and hydrochloric acid ¼ part ammonia, and dilute the whole with an equal quantity of water. This has been very successfully used on knitting machines in soldering kneedles to their holders where an acid with the above characteristics is essential. J. H. V.

202. MIXTURE FOR CLEANING GRIMY HANDS.

A good mixture for cleaning grimy hands is made by pounding a cake of "Sapolio" or "Bon Ami" up quite fine, and stirring it into a cupful of pure leaf lard, heated very hot. Stir until well mixed and when it is partly cool pour into a tin or tins of convenient size to get the fingers into.

Worcester, Mass. M. E. HOWE.

203. TO REMOVE GREASE OR DIRT FROM MERCURY.

To cleanse mercury first put a ten per cent solution of nitric acid in an iron ladle, and then the mercury to be cleaned; place same over a blacksmith's forge until the nitric acid boils. The dirt will then rise to the top, and leave the mercury perfectly clean in the bottom. Care must be used not to let the mercury boil, as the fumes are very poisonous.

H. C.

204. A BELT CEMENT.

To make a reliable belt cement use 1 pound of Peter Cooper's white glue and 1 ounce of powdered white lead; mix like ordinary glue (thick). When used it should be thinned to the required consistency with grain alcohol and applied hot. This cement is particularly valuable where long hard usage is required such as for dynamo belts. J. H. V.

205. HARDENING FORMULA FOR CUTTING TOOLS.

To make a hardening solution for metal cutting tools mix saltpeter, 2 ounces; salamoniac, 2 ounces; alum, 2 ounces; salt, 1½ pound; and soft water, 3 gallons. Keep the solution in a stone jar for it will eat a wooden tub and rust an iron pot. Do not draw the temper but only warm the tools enough to relieve the hardening strains. It is also well to rinse the tools well in water, for if this is not done, the solution will rust them. TOOLMAKER.

206. TO CASE HARDEN CAST IRON.

I have successfully case hardened cast iron, using the following receipt: Pulverize and mix together equal weights of saltpetre, prussiate of potash and sal-ammoniac. Make a dipping solution by adding to each quart of cold water 1 ounce prussiate of potash and ½ ounce sal-ammoniac. Heat the cast iron pieces till redhot, roll them in the powder, and then plunge them into the liquid. J. M. MENEGUS.

Los Angeles, Cal.

207. TO SOLDER ALUMINUM.

The great disadvantage of aluminium to the sheet metal worker is the difficulty encountered in soldering. This is caused by the formation of an oxide on the surface of the heated metal, the oxide preventing the solder from alloying with the aluminium. This difficulty can be surmounted by employing the following method:

Make a solder of 80 per cent tin and 20 per cent zinc, and use stearic acid as a flux. Tin the surface wth the above, moving the copper bit backwards and forwards over the metal and flowing the solder. The film of oxide can then be cleaned off, and the coated surface can be easily soldered with the above named solder or ordinary tinsmiths' solder.

Manchester, Eng. A. EYLES.

208. TO IMPROVE THE COLOR OF SHELLAC VARNISH.

Occasionally the shellac varnish used by the pattern maker for varnishing very nice patterns will seem to lose its clear, amber tint. It is frequently the case that the jar is cleaned out and a fresh lot dissolved. This does not always cure the trouble. Any desired depth of tint may be readily obtained by the addition of a small quantity of gamboge previously dissolved in a small quantity of alcohol. It should be kept on hand for this purpose. OSCAR E. PERRIGO.

Neponset, Mass.

209. WIRE ROPE GREASE—GREASE FOR GEAR WHEELS.

A mixture of ¾ oil and ¼ colophony (rosin), will be found to be a very good lubricant for wire ropes such as used on power transmitting and conveying machinery, if applied warm. Boiled linseed oil also answers same purpose when high speed is required.

A good grease for gear wheels where iron meshes into iron can be made of 1 part of graphite, 4 parts of tallow mixed with some oil. For steel gears meshing into wood 1 part of graphite, 2 parts of beeswax and ½ to 1 part of tallow will form a very good and lasting grease for same.

Cleveland, O. MAX J. OCHES.

210. CEMENT FOR BELTS.

Mix 5 ounces bisulphite of carbon with ½ ounce spirits of turpentine, and enough gutta percha to make a paste. Thin the ends of the belt so that when they are joined the thickness at the joint is the same as the thickness of the belt. If the belt ends are greasy, apply some blotting paper and a hot iron to free them from grease. Then apply some of the paste, and press the parts together, using screw clamps and two pieces of board of the same width as the belt. The cement will dry in a short time, when the clamps can be removed. I have cemented belts in this way at night, and in the morning they were as nicely joined as could be wished.

Los Angeles, Cal. J. M. MENEGUS.

211. COPPER PLATING CAST IRON.

In the process of covering cast iron with a coating of copper the pieces of cast iron are first placed in a bath made of 50 parts of hydrochloric acid, specific gravity 1.1, and one part of nitric acid; they are next immersed in a second bath comprised of 10 parts nitric acid and 10 parts chloride of copper dissolved in 80 parts of hydrochloric acid, specific gravity 1.1. The pieces are then rubbed with a woolen cloth and immersed again until the desired thickness of copper is deposited. To give a bronze appearance the copper surface is rubbed with a mixture of 4 parts sal ammoniac and one part each of oxalic acid and acetic acid dissolved in 30 parts of water.

New Haven, Conn. A. L. MONRAD.

212. A GUN-METAL FINISH.

To make an imitation gun-metal finish by electrical process take ¾ pound of the double nickel salts to a gallon, and dissolve in boiling water. After the solution has cooled, add ammonia until it is slightly alkalized, then add sulphuret cyanide of potassium, about ½ ounce to a gallon. If a darker finish is required add more sulphuret. This will work excellently on all metals and they will come from the solution with a very high luster. If the work has been buffed and dipped before plating, it will require no further finishing, and should then be lacquered. It should be run with a very mild current from three to four minutes. J. L. LUCAS.

Bridgeport, Conn.

213. SOLUTION FOR BLUING BRASS.

A suitable solution for bluing brass is prepared by dissolving 1 ounce of antimony chloride in 20 ounces of water and adding 3 ounces of pure hydrochloric acid. Any amount of solution may be made up, provided the different ingredients are in the above proportion. To apply, place the warmed brass article into the solution until it has turned blue. Then remove it and wash with clean water, after which dry in sawdust. T. E. O'DONNELL.

Urbana, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

18. J. A. S.: What is the standard taper of thread for oil well casing?

A. ¾ inch per foot.

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19. Inquirer:—In working out the design of a gas engine I had some trouble in finding its theoretical horsepower when using a mixture of one part illuminating gas to ten parts of air. As the problem stood I had a cylinder with 40 per cent clearance, which gave a compression of about 70.5 pounds per square inch. What will be the absolute temperature of compression and explosion and what the power of the engine using mixture given above? The engine has a ten-inch stroke and cylinder diameter of six inches and makes 300 revolutions a minute.

Answered by Dr. Sanford A. Moss.

No theoretical method is known for computing the power of a gas engine. Observation of existing engines using illuminating gas shows a "Mean Effective Pressure" of about 70 pounds per square inch for an engine of the size given, using a compression pressure of 70 pounds per square inch. This is for the best possible mixture of air and gas; that is, the mixture giving greatest power. The M. E. P. varies with size of engine, compression pressure, arrangement of combustion chamber, valve area, jackets, etc., so that a definite rule is not possible, and values obtained from observation of existing engines are the only ones possible. Using the familiar formula for engine power the brake horsepower is

$$e \times \frac{(M.E.P.)\, L\, a\, x}{33{,}000}$$

where e is the mechanical efficiency, or ratio of brake horsepower to indicated horsepower; L is the length of stroke in feet; a is the cylinder area in square inches; and x is the number of explosions per minute. In an average engine e has a value of 0.80. In a four-stroke cycle engine x is equal to $N/2$. The value of 70 for the M. E. P. is an average value for small engines using natural gas or illuminating gas. Using above values, the formula reduces to:

$$\text{Brake horsepower} = \frac{l\, d^2 N}{18{,}000}$$

where l is length of stroke in inches, d diameter of cylinder in inches, and N revolutions per minute. A small four-cycle engine using natural gas or illuminating gas is supposed. The formula is only approximate.

The brake horsepower of a 6 × 10 four-cycle engine at 300 R. P. M. is about

$$\frac{10 \times 36 \times 300}{18{,}000} = 6 \text{ H. P.}$$

A mixture of one part of illuminating gas to ten parts of air is alluded to, and the absolute temperatures of compression and explosion are also referred to. These quantities are never known in any usual case, and can only be determined by most careful experiments and computations. The exact values of these quantities have no bearing on the practical problem of gas engine powering, and do not concern the gas engine designer in usual cases.

It is stated that a cylinder with 40 per cent clearance will give a compression pressure of 70.5 pounds. This compression pressure seems high, 50-pound gage being usually obtained with 40 per cent of clearance. About 30 per cent clearance is usually required to give 70 pounds gage.

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20. C. B. H.: Please give a formula for finding the radius of a circular arc when the length of the arc and the height of its middle ordinate are given.

A.—We know of no method by which the radius of a circular arc can be calculated when only the length of the arc and the height of its middle ordinate are known, although there is one for the converse, as when the length of the arc is required, having given the radius and the height of the middle ordinate. The following approximate formula for solving this is given in Haswell's handbook.

$$L = \frac{2c \times 10 \text{ versin}}{120r - 27 \text{ versin}} + c$$

in which

L = length of arc,

c = chord of half arc,

versin = height of middle ordinate,

r = radius.

The chord of half the arc is found by the formula

$$c = \sqrt{\tfrac{1}{4}C^2 + \text{versin}^2}$$

in which

c = chord of the half arc,

C = chord of the arc.

You will find tables in most engineer's handbooks giving the lengths of circular arcs and the equivalent height of the middle ordinate by small divisions up to a semi-circle.

* * *

An exceedingly interesting story is told by Mr. H. S. Cooper, manager of the Galveston Electric Co., in the May 12, 1906, issue of the *Street Railway Journal*, of the great difficulties imposed on the operation of his company by the raising of the grade of the city of Galveston. As all of our readers probably remember, Galveston was wrecked by a great ocean storm which flooded the city several years ago, and to prevent a repetition of this disaster the engineers decided to raise the grade level of about half the city, the fill varying from a few inches up to 9 or 10 feet. The method employed to convey the many millions of cubic yards of earth required was to pump a mixture of sand and water from the ocean bed through 42-inch pipes which were connected to great dredges outside the sea wall. In this way in a day of 24 hours there were often delivered from 12,500 to 15,000 cubic yards of sand, or the equivalent of, say, 1,000 railroad car loads. But, inasmuch as only from 25 to 33 1-3 per cent of the mixture pumped was sand, it represented a volume three or four times as great. The great volume of water which had to flow away made the difficulties of the street railway company simply enormous. Their tracks had to be raised during each flooding operation; at the beginning this consisted of clear salt water and the same at the end of each pumping period, this being necessary to prevent clogging of the pipes which would have resulted had the sand been left in them when pumping ceased. The flow of clear water would wash away the sand to begin with and then as the sand and water came the sand would be rapidly deposited on the tracks. The men would have to work with their feet sunk in a mixture of quicksand so deep that it was with difficulty that they could change their positions. Then, at the end of a pumping period, came the flow of water again, which would often wash away the sand from between the ties and cause them to settle from a few inches to several feet. During all this time the cars were kept running over a track whose sinuosity would rival that of a worm rail fence, both in lateral and vertical directions. The rusting caused by the salt water played havoc with the bonding of the rails and with the bearings of the cars. In fact it is hard to conceive of anything worse for machinery than a mixture of salt water and sharp sea sand. As the level of the tracks was raised, it was necessary to raise the poles carrying the feed wires, and this alone was a job of no small difficulty. The sand while wet was a quicksand which would flow almost like water, and it resisted the raising of the poles with enormous frictional resistance as well as an atmospheric pressure of practically 15 pounds per square inch. The yielding character of the surface sand made the use of improved mechanical devices for pulling the poles upward of practically no avail and the work was reduced to the use of 30-foot wooden levers working over "bait" supported on planks and with twelve strong men at the business end of the levers. Altogether it would appear, from the manager's entertaining description, that the Galveston Electric Co. successfully met difficulties of operation that were never equalled in the history of any other electric street railway company.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

A PULLEY CROWNING DEVICE.

The American Tool Works Co., Cincinnati, Ohio, have recently built an interesting pulley crowning device which is shown in the halftone, Fig. 1. The sectional view, Fig. 2, will perhaps make its operation a little clearer. The parts shown in the line cut may be readily picked out in the half-

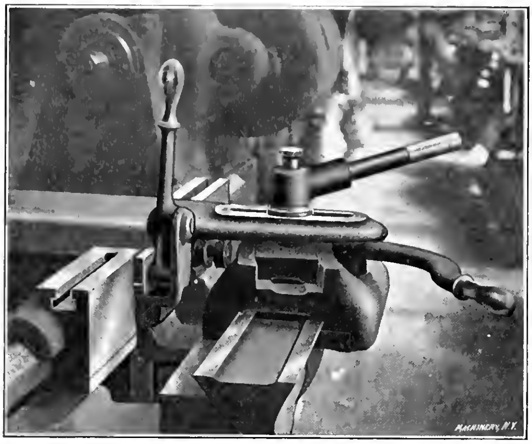


Fig. 1. Pulley Crowning Attachment.

tone. The basis of the device is the taper attachment furnished with the lathes built by this concern. The cross-feed screw *F* rotates freely in block *G*, but is held in position by it longitudinally. It may be rotated by the handle on shaft *K*, which is provided with a hole into which the screw *F* telescopes; it is driven from *K* by the key as shown. In the regular attachment the nut is attached to the cross slide *E* by the screw as shown, which, however, passes through a slot in the cross slide. When the taper attachment is in use this screw is loosened, thus permitting the guide bar to move the slide in and out without reference to the cross slide screw. As arranged for the pulley crowning device, however, the nut is permanently fixed to the slide.

On the supplementary way *C* at the rear of the machine is fastened the former, *B*, which has a groove machined in its upper surface on an arc corresponding to the radius of contour it is desired to give to the pulley which is to be crowned. In this groove slides the block *A* which is engaged, through a pivot center and clamp *D*, with the slotted extension *E* of must be thrown over. This action withdraws a fork from the slots in *G*, thus freeing it. When it is desired to use the lathe in the ordinary run of work this fork is again thrown in engagement with *G*, locking it in position and again giving the cross-slide screw control of the cross slide, after handle *D* has been loosened from its engagement with the slotted end of *E*.

To make provision for centering the curve of the pulley, a locating pin is provided at *H*. This passes down through the center of the pivot of block *A*. In the center of the arc in block *B* is a hole to receive the lower end of this pin. When knob *H* is pressed down and the pin inserted in this hole, clamp *J* may be loosened so that *B* slides freely on *C*. If then the carriage be moved until the tool point is exactly half way across the face of the pulley, handle *J* may then be tightened, pin *H* withdrawn, and the attachment will be centered so that the largest diameter of the pulley will be in the center of the face.

VOSPER PIPE CUTTING TOOL.

W. W. Vosper, 611 Osborne Street, Sandusky, Ohio, has invented and is manufacturing a pipe cutter, the principle of which will be readily understood from the following description and cut. As may be seen, the frame of the apparatus consists of a pair of hinged arms somewhat like old-fashioned fireplace tongs in their arrangement, but provided at the

Pipe Cutting Tool.

outer end with wide V surfaces for grasping the pipe. The thumb nut shown, acting on the threaded tie-bar, draws the V's together to suit the size of pipe being cut. The tie-bar has notches formed in its outer side which engage with a pin in the lower lug; when the bar is thrown out at an angle of 45 degrees it may be readily changed from one notch to another to suit different diameters of work. The tool shown will handle pipe from 2½ to 4 inches in diameter.

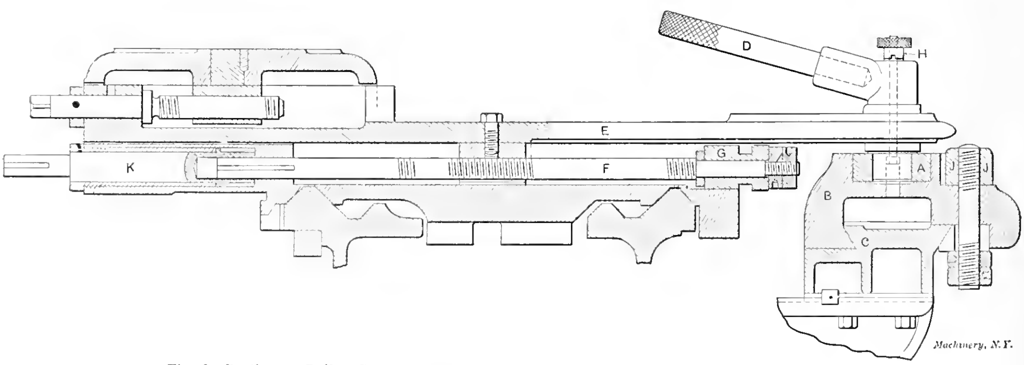
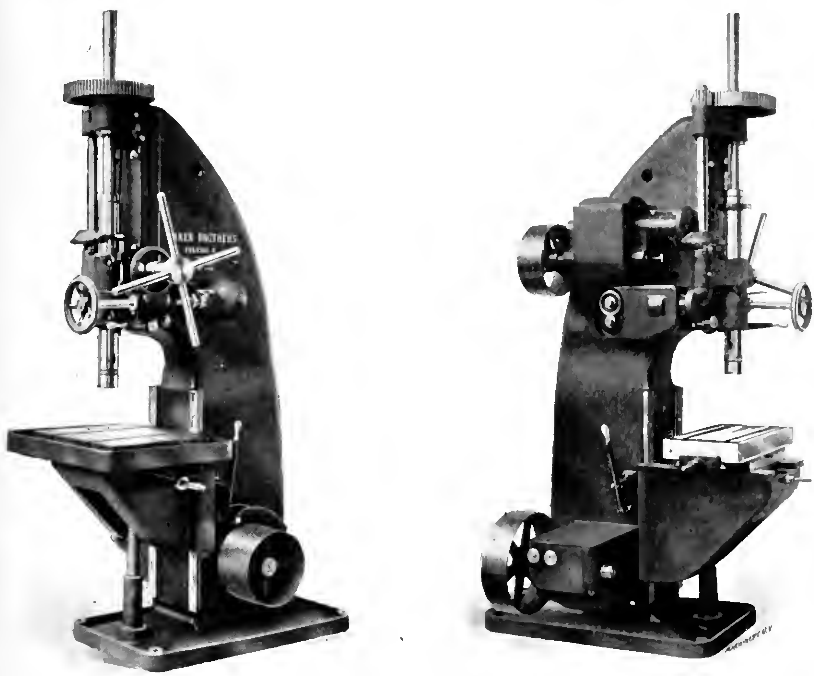


Fig. 2. Section of Pulley Crowning Attachment used with American Tool Works Co.'s Lathe.

the cross slide. It is thus readily apparent that with former *B*, located in position on the way *C* by clamp *J*, slide *E* will be given an in-and-out motion which will reproduce at the tool point the contour of the groove in former *B*. The fact that cross-slide screw *F* telescopes in *K* allows it to move in and out freely with the slide. To allow block *G*, however, to move longitudinally, the upright lever shown at the left in Fig. 1

The cutters are formed out of round disks about 0.05 inch thick. They are supported on supplementary arms hinged to the main frame of the device, and are drawn in by the constant tension of a pair of powerful springs, which are not very well shown in the illustration. The tension of these springs is more than enough to feed the cutter when the device is revolved. To prevent the taking of too heavy a chip,

in front of each cutting edge is fastened a shoe which rides on the work. The point of the cutter is just enough deeper than the point of the shoe to give a reasonably heavy cut. The thickness of the chip is thus a constant quantity no matter whether the pipe be round or of a distorted shape. To throw the tool out of action cams are provided, operated by the handles shown, which may be used to lift the arm away from the work and lock the tool in the outward position. The cutting edge of the blade is not square across, as is the usual case in pipe cutting tools. One of the cutters is beveled in one direction while the other is beveled the other way. This divides the chip, each of the tools cutting only half the full width, thus preventing the tendency to dig in and catch which is always present with a tool cutting the full width.



Baker High-speed Drill.

DRILL PRESS FOR USE WITH HIGH-SPEED STEEL.

Baker Bros., Toledo, Ohio, have designed a drilling machine, of which we show two halftone cuts above. This machine is arranged and proportioned to be especially suited to the requirement of driving $\frac{1}{2}$-inch to $1\frac{1}{2}$-inch drills made of high speed steel. The advantage which this type of frame possesses over the usual light design is in the avoidance of distortion under the pressure of a heavy feed with a large drill. If the main casting of the machine springs under the pressure of a cut, the drill will bind in the hole, especially if it be a long one; this results in a material increase in the amount of power required, which may be in extreme cases two or three times that required for removing the metal; this extra power is converted into heat which still further expands the drill, causing it to bind still more tightly; and finally the drill, when so cramped, is very liable to break. The design of the frame of this tool obviates all danger from these sources.

As may be seen in the cut, the machine is driven from a constant speed belt, direct from the line shaft, running onto tight and loose pulleys at the base of the column on the right hand side of the machine. From here the motion is transmitted through enclosed back gears to the intermediate pulley on the left hand side of the machine where connection is made by belt with the speed box at the upper end of the column. The change of speed here is made positively as is the case in the lower gearing, there being no ratchet or friction drives in the machine.

This drive gives the machine eight speeds, varying from 25 revolutions per minute to 370 revolutions per minute, thus covering the requirements for a tool to use either carbon or high speed steel drills, and adapting it to boring operations as well. The intermediate belt is liberally proportioned and will not slip under the most severe service, yet it will act as a safety device in the case of accidents. From the upper speed box the action of the driving mechanism may be easily traced through to the spindle. A positive feed is used which may be quickly changed, giving any one of three variations with a provision for compounding.

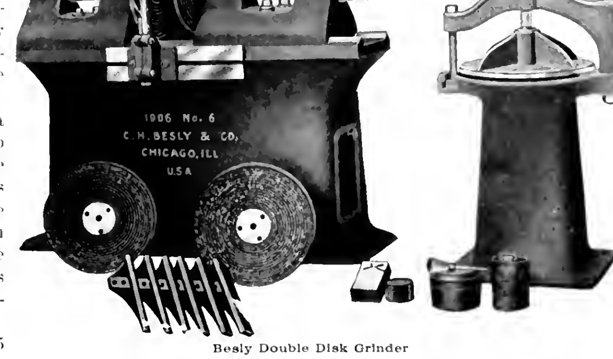
The table is gibbed securely to the front of the machine and is further supported by the elevating screw, which is heavy and capable of taking the entire thrust of the cut. The elevating screw works on ball bearings so that the table may be easily raised and lowered even though heavily loaded. A compound platen may be used, allowing the work to be quickly and accurately centered under the drill after it has been clamped to the table; when so centered the table does not have to be locked in place, but will stay wherever set. While one piece is being drilled another may be chucked on the opposite end of the table.

The bearings are all bronze bushings and the shafts are all ground. The back gears and speed change gears run in oil. It has been the intention of the makers to forestall any criticism on the score of either design or workmanship, and the questions of rigidity, driving power at high speeds, ease of manipulation, smoothness of running, wide range and durability have been the determining features of the design.

The spindle travel is 16 inches. The spindle is bored to fit a No. 4 Morse taper shank. The plain type of table is 17x23 inches inside the oil groove, while the compound style, like that shown in the right-hand cut, is 13x20 inches with a travel of 10x18 inches. The spindle will drill to the center of a 24-inch circle. The weight of the tool is about 3,000 pounds. Alternative arrangements may be specified, such as oil pump attachment, motor drive, etc. Provisions for these have been made in the original design.

BESLY DOUBLE DISK GRINDER.

The accompanying halftone shows a tool which its builders, Chas. H. Besly & Co., Chicago, Ill., have recently designed to perform certain operations constantly met with by users



Besly Double Disk Grinder

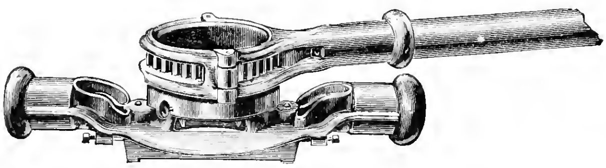
of disk grinders. As may be seen, the machine consists of two grinding disks of the usual type built by the makers, which are mounted in heads adjustable to or away from each other along ways on top of the column. Between these two disks is the table which supports the work, which may thus have two sides finished at the same time parallel to each other and perpendicular to the base on which it is supported.

To insure accuracy it is necessary that the spindles be parallel to each other and at right angles to the work table. With this end in view the heads are supported and guided on top of the column in the same way as is followed in engine lathe practice, V's being provided onto which the heads are clamped by the bolts shown in the cut. The spindle bearings, in accordance with the experience of the makers, are of cast iron lubricated with solid oil supplied by oil cups especially designed for the purpose. The end motion of the disks is controlled by adjustable keyed collars held in place by lock nuts at the ends of the spindles. The end thrust is taken on hardened and ground collars of large area. The in and out movement of the movable head is about one inch and special care has been taken to reduce the amount of sliding surface to a minimum. This surface is entirely enclosed in the bearing bushings, which slide with the spindle. This arrangement not only protects the bearing surface from dust, but insures that the disk wheel on the sliding spindle is always near to, and rigidly supported by the main head casting. The sliding spindle is brought up to the work by means of a pinion on the lever shaft, actuating a rack on the bushing at the rear bearing; this rack and pinion mesh vertically so that emery dust does not tend to lodge and wear the surface.

The work rest bracket is rigidly supported and the T-slot in the front of the bed and the V's on its upper surface make the machine readily adaptable for holding any special apparatus which may be required. Either or both heads may be removed at a moment's notice. The machine is equipped with 20-inch disks and weighs about 3,500 pounds, together with the countershaft, floor press and accessories. The bed casting has a 5½-inch opening for attaching an exhaust pipe to carry away the dust from the grinding operations.

A RATCHET ATTACHMENT FOR DIE STOCKS.

When threading pipe in confined quarters, in a ditch, for instance, or close in the corner of a room, it is generally impossible to use the ordinary two-handled stock, and one operating with a single handle on the ratchet principle becomes necessary. A number of these are on the market, most of which require that the buyer should purchase a complete stock in order to avail himself of the ratchet.



Armstrong Ratchet Attachment.

The Armstrong Manufacturing Co. of 297 Knowlton St., Bridgeport, Conn., are making the device shown in the cut which can be attached to one of their regular die stocks by the simple tightening of a thumb screw. In using this attachment the double handles are removed from the tool, one of them being screwed into the sleeve of the attachment where it is used to turn the dies. The parts are made of light but strong malleable iron castings. The pawl may be instantly adjusted for turning the die in either direction.

DAYTON CUTTER GRINDER.

The Dayton Machine Tool Co., Dayton, Ohio, are building a universal grinder, which is shown in the cuts working at about the extremes of its capacity in both directions. Fig. 1 illustrates the sharpening of a 12-inch cutter which is used to mill slots 1½-inch wide by ¾-inch deep in steel bars. The sides of the cutter as well as the front are ground with straight line clearance. This machine will take similar cutters up to 18 inches in diameter by 4 inches deep without extra fixtures other than the arbor on which the tool is supported. The second illustration shows the grinding of the end teeth of a T-slot cutter, using a cup wheel for this operation which is mounted on the internal grinding attachment spindle, thus giving the requisite speed and permitting the use of a wheel small enough to grind the smallest end mill.

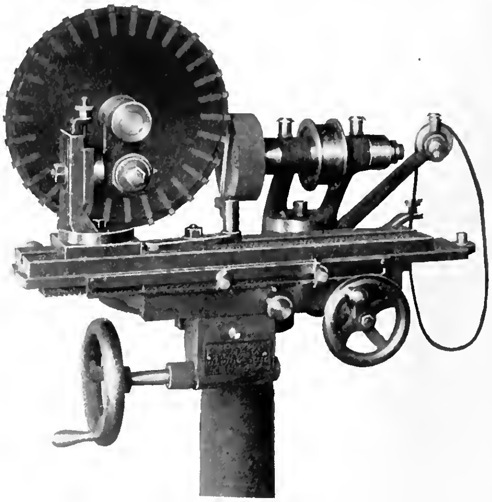


Fig. 1. Driving a 12-inch Mill.

On this job an index dial is used for spacing; this does away with the annoyance of using a tool rest on a small cutter. The internal spindle attachment can be set at any angle with the table, not being confined to any position, since it swivels with the wheel base and is practically an integral part of it. The

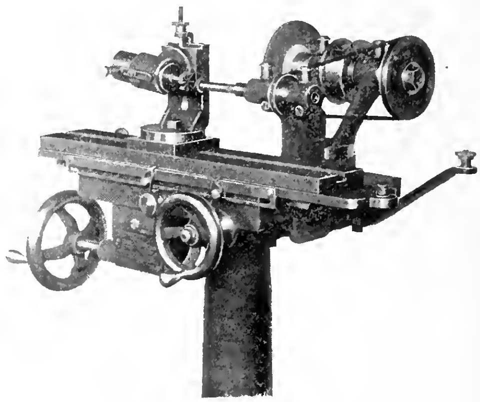


Fig. 2. Sharpening the Face of a T-slot Cutter.

main emery wheel spindle may be, of course, swiveled in a similar manner through an arc of 180 degrees, and may be locked in any required position. The makers will cheerfully furnish any one interested any further information that may be desired.

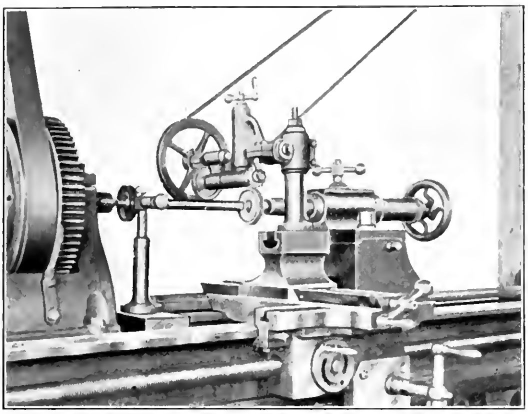
LATHE MILLING ATTACHMENT.

The accompanying halftone shows a device which may be used in connection with an engine lathe to perform a variety of milling operations. The cut shows the milling attachment fastened to the tool post of a lathe and engaged in the operation of cutting a gear blank which is secured to an arbor and mounted between centers. At the other end of the arbor is a lathe change gear which is being used as an index plate in spacing the blank. The cutter is driven independently from the line shaft, or from any other suitable source of power, by a right angled drive provided with an automatic take-up to allow the carriage to be moved to any position on the lathe shears. The depth of the cut is adjustable by the ball crank and screw shown, while the cross slide of the lathe allows the cutter to be set at any distance from the center of the machine that may be desired. The feed of the

lathe is used for feeding the cutter. The builders of this device, the Brickner Machine Co., 7 South Washington Street, Tiffin, Ohio, claim that it will do the work of an ordinary milling machine at one-sixth of the first cost.

THE PRENTICE HIGH-SPEED TURRET LATHE.

Prentice Bros. Co., Worcester, Mass., have developed a turret mechanism for their new high speed lathes which especially adapts them to the machining of castings. The turret, which is of hexagon shape and of large size, is mounted on the cross slide of the carriage, as shown in Figs. 1 and 3. Fig. 4 shows the design of the turret and the arrangement of the stops by which its motions are controlled. The diameter of the holes in the turret is $2\frac{1}{4}$ inches, and a space of 5 inches by 6 inches is available for attaching tool holders of various shape. It has a flat annular base and may be clamped to the slide by a stud passing through its center in the usual manner. The locking pin, *B*, Fig. 4, operated by the handle shown at the front of the slide in Fig. 1, is seated in a hardened bushing contained in a rim integral with the turret and projecting downward into a corresponding groove in the top of the slide. The lower edge of the downwardly projecting rim has teeth cut in it to form a large bevel gear, which meshes with the small pinion, *C*, keyed to the shaft, *D*, but is free to slide in or out thereon, according to the position of the cross slide. Shaft *D*, through a train of bevel and spur gears which may be readily traced, is connected with shaft *E*, on which is mounted drum *F* carrying a series of 6 adjustable stop screws, one for each hole in the turret. The speed ratio of this train of gearing is such that for every 1/6th revolution of the turret the stop drum will rotate 1 1/6 revolution, thus always presenting a definite stop for each face of the turret. In case it is desired to use two stops for one station, collar *G* may be moved back until the pin which connects it with drum *F* is withdrawn from engagement. Any stop screw desired may then be presented for action but when collar *G* is thrown in again, the drum will be returned to its former position since it is provided with but one hole for the connecting pin. The stops abut against the dog, *H*, which may be clamped in any position desired longitudinally in the T-slot furnished for it between the ways of the lathe bed.



Lathe Milling Attachment.

When the end of a stop screw and the face of the dog have come in contact the drum *F* and shaft *E* are arrested in their movement, and continued feeding of the carriage compresses the spring at *J* until the bushing at this point is clamped between the washer on the shaft and the main casting of the slide, when the carriage comes to a dead stop. Before this positive stop comes into action a throwout is operated which disengages the power feed. The spool *K*, which is pinned to shaft *E*, is connected with the rock shaft *L* in Fig. 2. When the forward motion of shaft *E* is arrested by contact of the stop screw with dog *H* the continued feeding of the slide rocks shaft *L* slightly, thus throwing the lower end of level *M* to the right and releasing the catch on the upper end of flange *N*, which is thus allowed to drop under the pressure of the spring shown until it comes in contact with projection *O*, which action, through the medium of the bell crank *P* throws out the clutch *Q*, which plays between the two bevel gears on the feed rod, and thus disengages the feed. The parts are so arranged that this release of the power feed takes place just before the positive stop comes into action, thus leaving a few thousandths for the workman to feed with the pilot wheel. This gives a better and more accurate finish to the shoulder than could be obtained by an absolutely automatic stop.

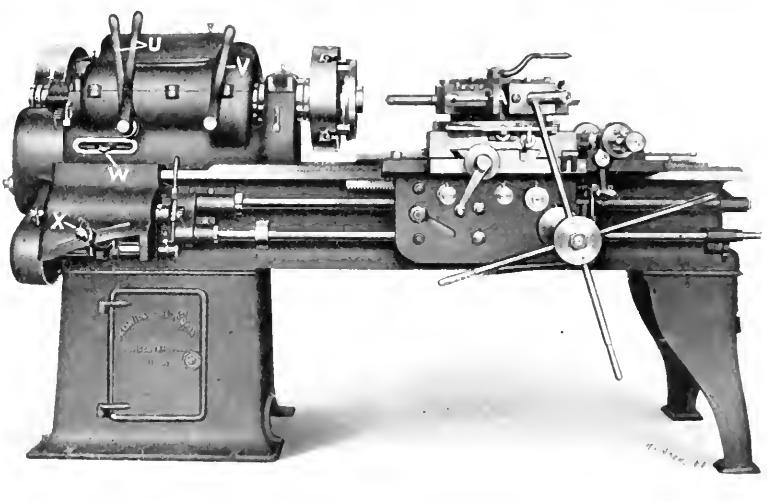


Fig. 1. Prentice High-speed Turret Lathe.

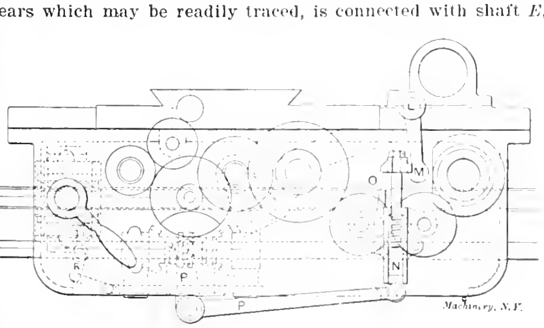


Fig. 2. Apron of Prentice High-speed Turret Lathe.

When it is desired to reverse the feed of the carriage or the cross slide, both of which are controlled by lever *P*, and the clutches and bevel gears at *W*, the catch on the upper end of plunger *N*, which is provided with a handle as may be seen in Fig. 1, is revolved until it no longer is engaged by projection *O*. The spring then forces the plunger to the bottom of its travel and the feed is driven through the bevel gear at the right of *Q*. Besides the splined feed rod a screw is provided which is used for thread cutting and for heavy feeding. An interlocking lever, *R*, is provided which moves in unison with bell crank *P* and is provided with a pin engaging in a slot in the split nut which engages the screw. This arrangement, as will be readily understood by an examination of the drawing, makes it impossible to engage the screw feed and the rod feed at the same time.

On the rear of the carriage are the cross slide stops, of which there are one on each side for each station of the turret.

These stops are revolved by hand and abut against adjustable dogs at the side of the cross slide; they automatically stop the friction cross feed at any point desired on either side of the center line. The cross feed is 7½ inches. The combination of cross and longitudinal stops and the large clamping surface provided for the tools on the turret, adapt this machine to the economical handling of both simple and complex work.

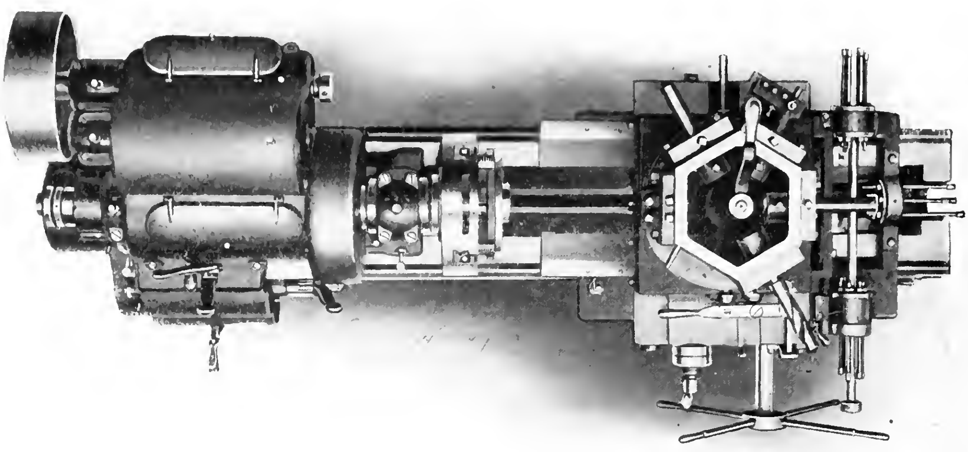


Fig. 3. View Looking Down on Prentice High-speed Turret Lathe.

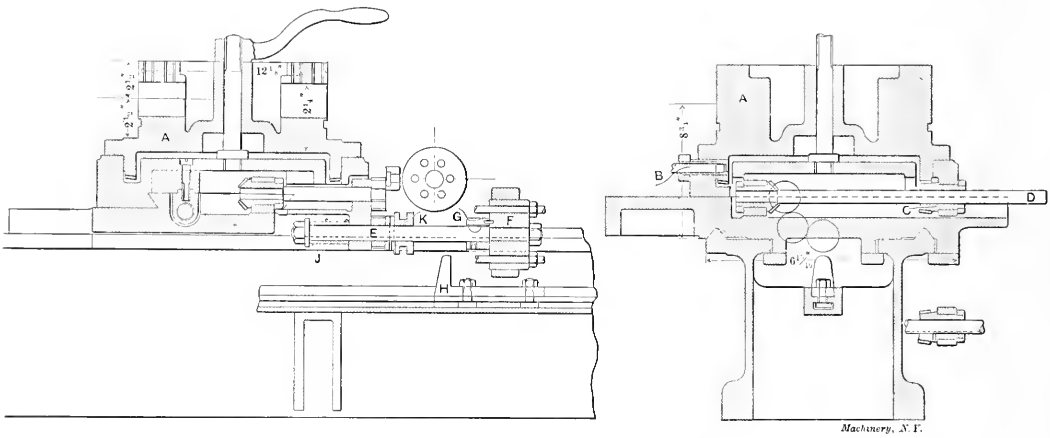
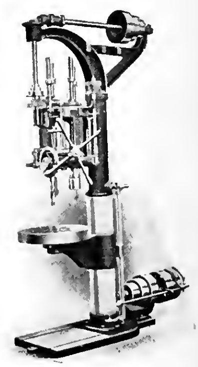


Fig. 4. Construction of Turret, Prentice High-speed Lathe.

The head stock mechanism is the same as that provided with their high speed engine lathe. It is driven by a 4-inch belt on a constant speed pulley 14 inches in diameter at *T*, and eight changes may be obtained in the head stock by operating the friction clutch levers, *U*, and the back gear lever, *V*. If a double speed countershaft is used this number of speeds may be multiplied by two. A wide range of speeds is of course necessary for a machine of this type where facing cuts on castings of large diameter are of constant occurrence. An all-geared feed is provided. Four changes may be obtained by handle *W*, and eleven by lever *X*, thus giving forty-four feeds in all.

MULTIPLE-SPINDLE DRILL.

The National Separator & Machine Co., Concord, N. H., build the upright drill press shown in the halftone. The machine is designed for drilling, tapping, reaming, etc., on duplicate parts without necessitating the changing of the tool or the work. As shown, it is provided with four spindles, but as many as six may be provided if the work on which it is to be used requires it. The construction will be evident from an examination of the cut. The drive is similar to that of the usual form of drill press so far as the use of the cone pulleys and the upper horizontal shaft driving the spindle through bevel gears, is concerned. The spindles, four or six as the case may be, are mounted in a skeleton drum which is revolvable about a vertical axis in a casing clamped to the column. Each spindle as it is brought into place is connected by a gear at its upper bearing with either one of the two driving gears on the vertical driving shaft. This allows a choice of speeds for the different tools. The feed is handled either by the pilot wheel, the hand wheel, or by power through the feed cones driven by the upright shaft. The locking mechanism is close to the spindle in use, so that the construction is very rigid. Each spindle has an independent stop.



National Multiple-spindle Drill.

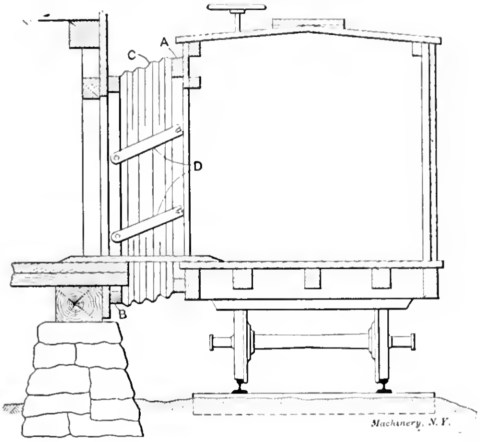
* * *

The full load deflection of structural beams should, in general, be limited to about 0.0025 of the span; that is, if the span be 20 feet, the deflection in the center under full load should not exceed 0.6 inch, or at most ⅝ inch. Beams may be chamfered so that greater deflection may be allowed without causing noticeable ragging of ceilings, etc., but this practice is not to be recommended.

ITEMS OF MECHANICAL INTEREST.

A PULLMAN VESTIBULE FOR THE SHIPPING ROOM.

In the dead of winter when the thermometer is away down and the wind velocity is away up, the opening of a door in the shipping or receiving department for the purpose of transferring freight between the building and a box car has the effect of cooling the room to such an extent as to make it a very uncomfortable place to work in. To overcome this difficulty, the R. K. Le Blond Machine Tool Co., of Cincinnati, use



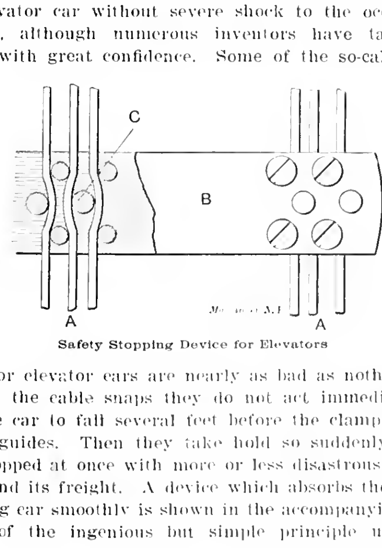
Keeping the Cold Air out of the Shipping Room.

a little vestibule arrangement which makes an enclosed passage way between the shop and the car. A sketch of this is shown herewith.

A light rectangular frame work *B* surrounding the shipping door is fastened to the outer wall. A similar framework, *A*, is connected to this by two swinging arms, *D*, on each side, and between these two frames is fastened the tube *C* of heavy close woven duck, or some other similar material. When the box car is in place, as shown by the sketch, it will be readily seen that the weight of the outer frame work, *A*, acting on the arms *D*, tends to hold it firmly against the side of the car, thus forming an enclosed passage way between it and the building tight enough to prevent the wind from entering to any great extent. When this arrangement is not in place it may be folded up against the side of the building, bellows-fashion. The device is so effectual that one can almost walk into the car, if he be a stranger, without realizing what sort of a place he has gotten into.

SHOCK ABSORBER.

The matter of stopping a rapidly falling body, such as a loose elevator car without severe shock to the occupants is not easy, although numerous inventors have tackled the problem with great confidence. Some of the so-called safety

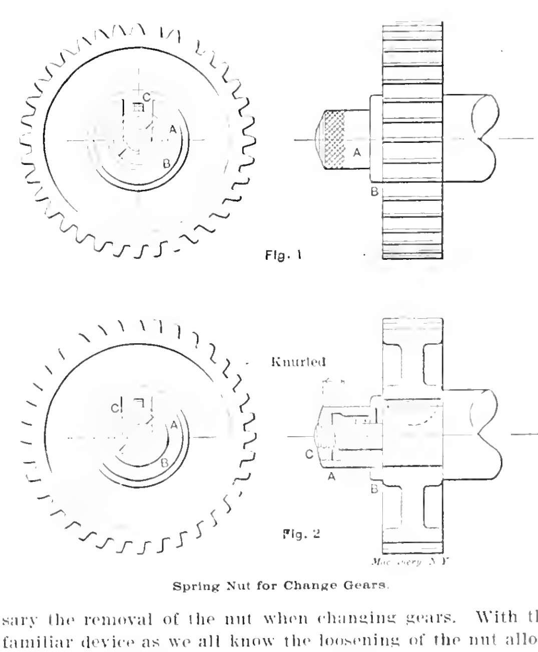


Safety Stopping Device for Elevators

devices for elevator cars are nearly as bad as nothing at all, for when the cable snaps they do not act immediately, but allow the car to fall several feet before the clamps grip the elevator guides. Then they take hold so suddenly that the car is stopped at once with more or less disastrous effects on the car and its freight. A device which absorbs the shock of the falling car smoothly is shown in the accompanying sketch, because of the ingenious but simple principle used. This device, unfortunately, was backed by certain parties in such a way as to give it an unsavory reputation, and it has never come into common use. It is illustrated merely to show a principle that may be useful in other directions where a uniform and reliable stopping effect is required and in which the surface conditions will not affect the stopping action materially. As shown in the cut a number of parallel wires, *A*, are strung, and on these are mounted at intervals clamps, *B*, in which are located a number of screws or pins so placed that the wire is kinked slightly between the adjacent pins. Now, it is obvious that any displacement of *B* will produce successive bending of the wires, the resistance depending on how much the kinking or bending is. The surface condition of the wire will make little difference in the resistance, as the greater part of it is due to internal and not surface friction. In use as an elevator device, a number of such clamps are provided one, at least, for each floor, and movable hooks or dogs are so worked that when a car falls they must engage these clamps and drag them down with the car. If one set of clamps is not sufficient to break the fall it would very soon come in contact with another set and so on, the velocity being gradually lessened until it comes to a full stop.

SPRING-NUT FOR CHANGE GEARS.

The accompanying cuts, Figs. 1 and 2, show end, side and section of an interesting and convenient device for facilitating the shifting of change gears on screw-cutting engine lathes. It is a feature of the "Star" lathes made by the Seneca Falls Mfg. Co., Seneca Falls, N. Y., and is an extension of the well-known slip collar idea which, in connection with a bore in the change gears larger than the nut makes unneces-



Spring Nut for Change Gears.

sary the removal of the nut when changing gears. With this familiar device as we all know the loosening of the nut allows the collar to be slipped off laterally and then the gear is pulled off over the nut. The device here illustrated goes this arrangement one better for it makes the use of a wrench unnecessary, the knurled piece, *A*, being merely pulled out longitudinally far enough to disengage it from the annular recess turned in the face of the coller *B* so that the latter can be slipped off sideways and then the gear is pulled from the stud. The cut illustrates the construction clearly; it shows that the spring is retained in place by the nut, *C*, which is slotted for a pronged screwdriver, but inasmuch as this part never has to be disturbed the use of tools is entirely unnecessary in the ordinary working of the device.

* * *

Don't plane a heavy chip off from a casting, without chipping or filing the back corner off to a bevel as far down as the tool goes; this avoids breaking out.

OBITUARY.

Charles C. Newton, president and treasurer of the Newton Machine Tool Works, Inc., Philadelphia, Pa., died at Bremen, Germany, on June 13. Mr. Newton had not been in good health and went abroad to seek relief at the baths at Bad, Nauheim, Germany, but was too ill to continue his travel after his arrival at Bremen.

Mr. Newton held an enviable position in the business and engineering world through his ability as a designer of machine tools and the success of the firm of which he was the founder. His designs have been characterized by originality and he was a pioneer in the development of cold sawing machines for metal and later on, portable floor plate machines now used so extensively in heavy machine work.

Charles C. Newton.

He was born at Cambridge, N. Y., in 1846. At nineteen he indentured himself as apprentice to the Brooks Locomotive Works, Dunkirk, N. Y., spending most of his time in the tool room. After serving his apprenticeship and working in various shops, Mr. Newton returned to Dunkirk in 1875, and in partnership with J. D. Cox manufactured twist drills, reamers, cutters, etc. In 1876 the firm moved to Cleveland, O., operating under the firm name of Newton & Cox. In 1880 Mr. Newton sold out his interest to Mr. Cox, who formed out of the old firm the Cleveland Twist Drill Co.

Removing to Philadelphia, Mr. Newton laid the foundation for the present Newton Machine Tool Works, Inc., in a little shop at 2341 and 2343 Callowhill Street, with only himself and an assistant as the working force. In this shop he designed the first heavy railroad tools, and as the demand grew for his various designs, he was forced to seek larger quarters. In the fall of 1886 he built a new shop at the corner of 24th and Wood streets and there designed the first successful machines for sawing metal cold, and also a large number of new tools, for which he took out patents. As this shop soon became too small, Mr. Newton built in August, 1895, the first part of the present shop on the corner of 24th and Vine streets, which he has since increased to take in the entire square bounded by 23d, 24th, Vine and Wood streets.

Mr. Newton was the sole proprietor of the works until July 14, 1897, when articles of incorporation were taken out, not with a view of increasing the capital, but as a business move, and the firm became the Newton Machine Tool Works Inc., with Mr. Newton as president and treasurer.

Mr. Newton was a member of the Engineers' Club, American Society of Mechanical Engineers, the Art Club of Philadelphia, and the Athletic Club of Philadelphia.

* * *

PERSONAL.

F. W. Aurig was recently made superintendent of the Eastern Auto Co., Philadelphia, Pa.

Fred P. Gates, of the Mergenthaler Co., of Brooklyn, N. Y., has taken a position as superintendent of the Bantam Anti-Friction Co., Bantam, Conn.

J. H. Gill has resigned his position with the Millikin University, Decatur, Ill., to take charge of the department of machine construction at the University of Illinois.

Carroll Ashley, the author of "Practical Planer Kinks" and a contributor to MACHINERY and other mechanical papers, is now with the Ritter Dental Mfg. Co., Rochester, N. Y., as foreman of the toolroom in their chair department.

A. L. Monrad, who has been with the Winchester Repeating Arms Co., New Haven, Conn., in the model and gage department for the last eleven years, has resigned to accept a position as superintendent with the H. A. Adams Tool Co., Hartford, Conn.

Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Co., Ampere, N. J., sailed June 14, on the Lloyd steamship *Barbarossa* for a short European trip. He was accompanied by Prof. Francis B. Crocker, professor of electrical engineering at Columbia University, who has been associated with him in business for many years.

Geo. H. Baush will represent Hill, Clarke & Co., machinery dealers, in Philadelphia, with the office located probably in the Bourse. He will take charge of the principal agencies of his company. Mr. Baush was for twelve years connected with the Baush Machine Tool Co., Springfield, Mass., holding various positions, including that of vice-president and general superintendent, and he has an extended acquaintance in the machine tool trade.

George I. Rockwood, the well-known consulting engineer and expert in steam engineering, has been appointed to the professorship of steam engineering at the Worcester Polytechnic Institute. Mr. Rockwood graduated from this school in 1888 and first became prominently known through his advocacy of the high-ratio compound steam engine which has given excellent mechanical results. He has lately been engaged both in consulting practice and in the manufacture of steam engines.

At the celebration of the seventy-fifth anniversary of the Koeniglich Preussische Technische Hochschule, of Hanover, Germany, one of the most prominent scientific institutions in the world, the honorary degree of Doctor of Engineering was conferred on Mr. Ernst Koerting, the noted European engineer, and of the well-known firm of Gebr. Koerting, A.G., Koertingsdorf, Hanover, for his scientific researches and discoveries in gas engines, and other important branches of engineeering. Dr. Koerting lives in Pegli, Italy. He is interested in a number of large enterprises in the United States, among them the De La Vergne Machine Co., of New York, as well as the Schutte-Koerting Co., of Philadelphia, and is at present sojourning in this country.

Niles A. Christensen, the inventor of the Christensen air brake and air compressor largely used on street railway cars, has joined the Allis-Chalmers Co. in an engineering capacity in connection with the manufacture of his air brake and air compressor, the Allis-Chalmers Co. having purchased the exclusive rights for their manufacture and sale. A mechanical plant of original design is being fitted up in connection with the present Allis-Chalmers plant at West Allis, and within the next few months it is expected that 800 or 900 men will be employed in this branch of their business. Mr. Christensen was born in Denmark in 1865 and has had a career of considerable interest, both abroad and in the United States. He came to the United States in 1891, and in 1894 the Christensen Engineering Co. was organized in Milwaukee for manufacturing air brakes and compressors. In 1897 it was merged into a new corporation, the National Electric Co., but this company met with troubles and financial reverses in 1905, which finally resulted in Mr. Christensen's alliance with the Allis-Chalmers Co. as stated above.

* * *

The collecting of stamps of various countries is a widespread fad and the supplying of stamps to collectors has reached the proportions of a respectable business with a number of concerns. The stamp collector is a person who combines intelligence with means and a certain amount of leisure, and naturally is of a critical disposition. It is therefore, of some interest to know how the stamp collectors look upon United States stamps as regards printing, finish, engraving, etc., in comparison with foreign stamps. It is not only interesting, but somewhat mortifying to our pride in American

things mechanical to know that United States stamps are not regarded highly as compared with others. One leading stamp collecting house says that as regards "centering," United States stamps are perforated very poorly in comparison with those of other countries. "By examining a sheet of new stamps it will be found that even if some stamps are perfectly centered other stamps in the same sheet will be badly out. Only a very small percentage of United States stamps are carefully centered and these are regarded as fine." Now, so far as the average user of stamps is concerned it makes not the slightest difference whether the perforations of a stamp are made so that an even amount of white border is left all around, but it does seem that such an important government department as our Bureau of Engraving would take into consideration matters of this kind and endeavor to block their plates and perforate the sheets of stamps so that glaring errors of perforation would not be so marked. It is the little things like this that give foreigners the impression—and rightly, too, perhaps—that the people of the United States are careless and slack in the niceties of finish which are required by people of thorough and artistic make-up.

* * *

FRESH FROM THE PRESS.

THE first number of the *Selling Magazine* has appeared and contains 32 pages of bright business talk, right to the point, upon the marketing of machinery and manufacturing products. The magazine is published by Emerson P. Harris, the well-known broker in periodicals, and is edited by John Kershaw, for several years prominently connected with the advertising department of the Hill Publishing Co.

We have received a copy of a new edition of "A Manual for Engineers" published by the University of Tennessee, Knoxville, Tenn. It is issued in vest pocket form and contains a great deal of condensed information of special interest to mechanical engineers. We are informed by the university that 30,000 copies of this little book have already been disposed of, indicating that it is valuable as a reference book to the busy engineer. The price is 50 cents.

A bound copy of the report of the 24th annual meeting of the American Street Railway Association held at Philadelphia September 27 and 28, 1905, has been received. It is attractively and comprehensively gotten up and contains a number of halftones of officers of the association and of plants and installations referred to in the papers, besides line cuts and diagrams. The official organization for each year since its inception in 1882 is an interesting and valuable feature. The papers read before the meeting, "Application of Gas Power to Electric Railway Service," "Electric Railway Equipment," "Notes of Design of Large Gas Engines with Special Reference to Railway Work" and "The Single Phase Railway System" are printed together with the discussions.

BURNS' PIPE PRICE EXTENDER, arranged by Eugene Burns. 32 pages 3¾ x 6½ inches. Published by David Williams Co., New York. Price 50 cents.

The "price extender" consists of a series of tables for conveniently finding the price of any length of common sized pipe and is based on the present list price for black and galvanized merchant pipe. The price of any length of common pipe is obtained by simple addition. For example, the price of 58 feet 4 inches of 5-inch pipe, whose list price is now $1.45 per foot, is found by referring to the table giving the price of 5-inch pipe in inches and feet up to 100 feet and adding the price of 58 feet and 4 inches, being $84.10 and $0.483 respectively, or a total of $84.583. The same table may be used for lengths longer than 100 feet by simply finding the price for the first two figures of the total number of feet and moving the decimal point to the right as many places as are required for the number of digits and then proceeding with the remainder in the same manner. The price extender is intended, of course, for the use of merchants and dealers in pipe.

THINGS THAT ARE USUALLY WRONG, by John E. Sweet. Published by the Hill Publishing Co., New York, 52 pages, illustrated, price 50 cents.

This little book is in the main a reprint of a series of articles published by Prof. Sweet in the *American Machinist*. Those who have wandered through the works of the Straight Line Engine Co. under the guidance of Prof. Sweet and had explained the various little mechanical niceties and details of construction that he has introduced, not only in the Straight Line engine, but in the tools and appliances used in his shop, will recognize the source of many of the illustrations and comments found in these pages. He has pointed out in his original way many features of design commonly met with in everyday practice, and passed by unthought of by the average mechanic. We believe the book will not only prove entertaining but exceedingly valuable to "mechanical engineers, students, machine designers and inventors and that most of the readers will wish there was more of it," to quote the words and the expressed hope of the author in his preface.

FIRST ANNUAL REPORT OF THE IOWA STATE HIGHWAY COMMISSION. 74 pages 6 x 9 inches, illustrated with 26 cuts.

The enormous importance of good highways to the country at large makes intelligent work of any community for such improvements of unusual interest. For the year 1904 the estimated hauling on the country roads in Iowa was over 32,000,000 ton miles, and this large figure only includes the hauling done in full load. The average size of loads was about 2,100 pounds and the average distance to market about four miles. Good highways are of fully as much importance as good railroads. A good highway enhances the value of farm lands and reduces the cost of carrying products to market. As matters now stand, the average cost of hauling grain from the farm to the nearest railroad station is about equal to that of transporting it 250 miles on the railroad, taking four miles as the average distance of the farm from the nearest railroad station. Within a few years an important discovery has been made regarding the maintenance of dirt roads, and that is dragging them with a split log immediately after every heavy rain. This fills in the ruts, squeezes out the water and grades the track each way from the center so that the road soon dries—and a dry road is usually a good road. The condition of roads before and after working is shown by halftones, and a number of other good cuts of equal interest are given.

TWENTIETH CENTURY MACHINE SHOP PRACTICE. By L. Elliott Brookes. 531 pages 5¼ x 7½ inches and 423 cuts. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $2.00.

This book is a compilation of rules of arithmetic, geometry, mensuration, applied mechanics, and includes chapters on the properties of steam, the indicator, horsepower, measuring devices, machinists' tools, milling machines, gas furnaces, shop kinks, etc. The mathematical section of the book is gotten up in good style, and is a creditable job, but the treatment of tools, machines, screw cutting, etc., is very weak and meager. The cuts are almost entirely large reproduced catalogue cuts and the descriptions are of a perfunctory character, telling things that are either obvious or of no earthly value save to a possible purchaser of the machine, being virtually in fact reproductions of catalogue descriptions. The section on screw cutting gives no rule whatever on compounding, and it is obvious that to most machinists this information is required more than the rule for simple gearing which latter almost any one beyond the rank of the apprentice understands. In short the book is not in the same class with Vandervoort's "Modern Machine Shop Tools," of which it appears in a measure to be an imitation. Many parts of the book could be severely criticised and, for example, mention may be made of a table giving the cutting speeds and feeds of lathe tools. This table gives a roughing cutting speed of 63 revolutions per minute on steel for diameters of 1 inch or less, which means a maximum cutting speed of about 16 feet per minute. For diameters of 3 inches to 6 inches, 48 revolutions per minute are recommended, meaning a maximum speed of about 76 feet. This curious discrepancy is found throughout the table, as for example, in cast iron a roughing cutting speed of 121 revolutions per minute is recommended for diameters of 1 inch or less, while for diameters of 12 to 20 inches 63 revolutions per minute is quoted, the former meaning a surface speed of about 32 feet per minute, and the latter a maximum of about 330 feet per minute for roughing cuts.

MODERN ENGINEERING PRACTICE. In 12 volumes. 6,000 pages. 6½ x 9½ inches and 4,000 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, $60.00.

This valuable work of encyclopedic dimensions is compiled from the best instruction papers comprising the courses of the American Correspondence School in electrical, mechanical, stationary, marine and locomotive engineering, shop practice, toolmaking, forging, founding, patternmaking, heating, ventilation, refrigeration, mechanical drawing, alternating current work, electric lighting and wiring, telephone, etc. The editor-in-chief is Frank W. Gunsaulus, president of the Armour Institute of Technology. The staff of writers and collaborators include fifty-nine professors, engineers and others, among whom are Prof. F. B. Crocker, of Columbia University; Prof. Esty, of Lehigh University; Prof. Derr, of Massachusetts Institute of Technology; Arthur L. Rice, editor of *The Engineer;* Francis H. Boyer, consulting engineer; Walter B. Snow, mechanical engineer B. F. Sturtevant Co.; Geo. L. Fowler, consulting engineer; Chas. L. Hubbard, consulting engineer S. Homer Woodbridge Co.; Chas. L. Griffin, mechanical engineer Semet-Solvay Co., and many other well-known names too numerous to mention.

It is impossible within the limits of this review to adequately cover or even to give a thorough account of the contents of the various volumes and we shall content ourselves in the main with speaking of them as a whole. The matter is prepared in the well-known style characterizing the work of correspondence schools, being written in clear, intelligent English and with no advanced mathematics. Any young man with a good common school education should be perfectly competent to read these books and understand the principles enunciated. The volumes are, however, intended more as a reference library than as text-books, although they are compiled from the instruction papers forming the courses of the school in the various branches enumerated above and may be used advantageously for study. The same characteristics are typical throughout. Following are the contents by volumes:

Vol. 1—Electricity, Wiring, Telegraph. Vol. 2—Generators, Motors, Storage Batteries, Automobiles. Vol. 3—Electricity, Light, Power and Railways. Vol. 4—Alternating Current Work, Transmission. Vol. 5—Telephony. Vol. 6—Chemistry, Heat, Boilers, Steam Pumps. Vol. 7—Steam Engines, Refrigeration, Gas Engines. Vol. 8—Marine and Locomotive Work. Vol. 9—Patternmaking, Founding, Machine Design. Vol. 10—Machine Shop, Toolmaking, Forging. Vol. 11—Mechanical Drawing and Perspective. Vol. 12—Ventilating, Heating, Plumbing, Carpentry, General Index.

The size of the work—6,000 pages—gives considerable space for the treatment of each subject, so that while no one subject is by any means exhausted it, however, receives a treatment that is far from superficial. For example, the section on machine design, which was of unusual interest to the reviewer, contains 180 pages and in itself comprises a valuable treatise on the subject. The same volume has a good treatment on patternmaking, 138 pages being given to this subject. Metallurgy and foundry work comprise the remainder of the volume. A feature of the work which should not be overlooked is the review questions at the back of each book in which are included a number of pertinent questions for self-examination by those who are using the volumes as a means of education. Volume 10 contains a treatment on machine shop work, toolmaking and forging, and Volume 11 is entirely given over to drawing, the first section comprising 362 pages, being devoted to mechanical drawing, following which is a section on perspective drawing and one on rendering which is of special value to those contemplating studies in architecture.

NEW TRADE LITERATURE.

THE NATIONAL MACHINE TOOL CO., Cincinnati, O. Leaflet of Key Seating Tools. A half-tone cut shows the tools in operation, and a table of net prices for the different sizes is given.

ALLIS-CHALMERS CO., Cincinnati, Ohio. Bulletin 1039. This treats of the subject Electrical Equipment of a Modern Shipyard, being illustrated by half tones showing types of Bullock motors in use.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, O. Catalogue of Locomotive Cranes, Buckets and Tubs. Some of the uses of locomotive cranes are given, standard 10-ton cranes are described, a number of engravings showing these machines in service.

PATTERSON GOTTFRIED & HUNTER, LTD., 146-150 Centre street, New York City. Catalogue No. 60 on Screws, including Bolts, Nuts, Washers, Nails, etc. Tables citing dimensions, styles, prices, etc., are given. An alphabetical index is inserted in the back of the book.

INGERSOLL-RAND CO., 11 Broadway, New York. Booklet Form 60A on Quarrying Machinery. Types of Channelers, Gadder, Drills, Displacement Pumps, etc., are illustrated and described in condensed form. Further information will be sent on request to those interested.

INGERSOLL-RAND CO., 11 Broadway, New York. Catalogue 74 A of Compressed Air Pumping Systems. This treats of costs, advantages, field of application, and takes up more specifically the Ingersoll-Rand Return-Air Pumping system and the pneumatic displacement pump. A few types of air compressors are also shown.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, O., have issued a handsome catalogue on Section "C," Open Hearth and Re-heating Furnaces. The engravings show some of these furnaces installed in a number of the large steel plants. A description of the construction of the product is contained in the text.

J. H. WILLIAMS & CO., Brooklyn, N. Y. New 1906 catalogue of Drop Forgings. New goods and additions appearing in this catalogue are noted on a leaflet which is issued with it. Some views inside the factory are shown. The product is illustrated throughout and specifi-

cations for the different types of wrenches, gages, screws, etc., are given.

B. F. Sturtevant Co., Boston, Mass. Bulletin No. 132 illustrates and describes Sturtevant economizer installations in the power houses of the Interborough Rapid Transit Co., the New Orleans Railways Co., the Boston Elevated Railway Co., the South Covington and Cincinnati Street Railway Co., and the Burlington Municipal Electric Lighting Co.

The New Britain Machine Co., New Britain, Conn. Illustrated circular of the New Britain band saw filer. This device, previously illustrated in Machinery, consists of a flat iron table in connection with a saw vise, together with a file attachment, which latter is guided by the table and enables the workman to secure uniform and accurate results.

C. Doering & Son, 223-229 West Lake Street, Chicago, Ill. Catalogue describing their tin, pressed steel, metal and other products, among which might be mentioned sheet steel shelving, pressed steel shop pans, oily waste safety cans, steel tool racks, lathe pans, etc. A description of the tin plating department and the sheet steel equipment is given.

The thirteenth number (June, 1906) of the *Progress Reporter*, issued by the Niles-Bement-Pond Co., 111 Broadway, N. Y., supersedes No. 4 September, 1904, and shows the capacity of the Pond Car Wheel Lathe doubled in two years. In one shop there is a record of 518 pairs of car wheels finished in 477 consecutive working hours, and in another shop 14 pairs were finished in 10 hours.

National Brake & Clutch Co., 16 State St., Boston, Mass., have printed a report of tests made on their Cork Insert friction surfaces by J. R. Nichols under the supervision of Ira N. Hollis at Harvard University, Cambridge. This report gives diagrams showing the variation in frictional resistance with varying friction loads. The coefficient of friction for this style of surface is from 0.33 to 0.35.

The Joseph Dixon Crucible Co., Jersey City, N. J., have issued a pamphlet, entitled Unions for Steam Pipes, which is an illustrated description of the several varieties of unions with suggestions concerning same by W. H. Wakeman, an expert steam engineer and author of several books on steam engineering. The material is reprinted from Dixon's house organ *Graphite*, and the company will gladly send a copy of the pamphlet free of charge to any one interested.

Crocker-Wheeler Co., Ampere, N. J., Bulletin No. 64 describing Form I motors and generators. These motors are shown driving various machines as sensitive drill, eight-foot boring mill, planer, facing machine, etc. Tables of outputs, net and shipping weights, general dimensions, etc., are given. Bulletin No. 65 points out the new features of C. W. core type transformers. These transformers are manufactured in all sizes up to 4,000 K. V. A., and for all voltages up to 200,000.

Ph. Bonvillain & E. Ronceray, Paris-Aubervilliers, France. Catalogue descriptive of the "Universal" system of machine molding patented by Messrs. Bonvillain and Ronceray. There is a general belief among foundry owners that machine molding is practicable only when a great number of castings of the same pattern are needed and where these castings are of a comparatively simple form. The "Universal" system is claimed to be practicably applicable to all forms of patterns without excessively heavy cost for fitting pattern plates, etc.

King Machine Tool Co., Cincinnati, Ohio. A novel and attractive pamphlet illustrating and describing their new 42-inch vertical boring and turning machine. Among the points to which attention is called is the resilient table drive provided, the clamping device for the tool holders, power rapid traverse in all directions, improved feed changing mechanism, and a single lever control whereby positive feed and a rapid traverse may be engaged in either direction by one lever.

A handsomely illustrated announcement of the Cincinnati **Fall** Festival and Industrial Exposition held annually in Cincinnati, has been received. This annual exposition was started several years ago mainly advertising the mechanical industries of Cincinnati, but it has developed into a general industrial exposition in which nearly all the various industries of Cincinnati take part. In connection therewith, of course, are many amusements and other features of a purely entertaining nature. Robert R. Reynolds is Vice-President; H. D. Crane, Secretary; and Edward H. Allen, General Manager.

The Ingersoll-Rand Co., 11 Broadway, New York City, have issued a number of new catalogues. Bulletins No. 2006 and 2007 on Labor Saving Tools describe "Imperial" pneumatic hammers and "Imperial" piston drills. Catalogue D43 opens with an interesting historical sketch of the rock drill, and proceeds to describe the different types of rock drills and drill mountings. Catalogue 136 has for its subject Imperial Type 11 Power-Driven Air Compressors. The details of construction are gone into at some length and tables of specifications are given. Form 64 describes a number of pneumatic tools, chipping hammers, riveting hammers, rotary drills, piston drills, etc.

The American Blower Co., Detroit, Mich., have added several catalogues to the new trade literature. Nos. 192, 195, 196, 202 and 203 are leaflets describing, in brief, "A. B. C." dryers, "A. B. C." Economy buffing hoods, "A. B. C." self oiling engines, which are lubricated without oil pressure, by pump and gravity feed, "A. B. C." electric disc fans, and "A. B. C." disc ventilating fans. No. 189, on Steel Plate Fans, contains the usual number of engravings, specifications, and convenient tables for reference. No. 190 treats of Blowers, Steel pressure blowers, volume blowers, fan blowers, etc., are described and illustrated. Catalogue No. 194 supplements Nos. 171 and 193 describing engines (types A and E) for small direct-connected generator sets. Disc Ventilating Fans are described in Catalogue 200. These fans are adapted to a variety of purposes, some of these being: ventilation of all types of buildings, removal of smoke, noxious fumes and gases, steam and dust, cooling of overheated apartments, heating and drying, etc.

The American Locomotive Co., 111 Broadway, New York, have issued a pamphlet describing electric motor and trailer trucks and illustrating the types of this equipment, designed and built by them. The pamphlet begins with a description of the principles of the de- signs, of which fifteen are illustrated by full-page drawings. Each illustration is accompanied by a list of dimensions. The designs illustrated include motor trucks for the New York Central suburban service, for the Paris-Orleans, the Schenectady, the Delaware & Hudson, the Brooklyn Rapid Transit, the Buffalo & Lockport, and other railways. The drawings show the construction in detail, rendering it an easy matter to study the designs. In addition to the drawings, nearly all of the trucks are illustrated by reproductions from photographs. Among the details illustrated are cast steel and wrought iron bolsters, truck hangers, spring planks, Brinkerhoff Doyle wheel hubs and journal boxes with collarless and collar axles. Copies of the pamphlet will be supplied upon request to the American Locomotive Company.

The International Correspondence Schools, Scranton, Pa., have issued a formidable volume of about 1,500 pages containing the names and addresses of 75,000 students who have either been awarded diplomas, or have made considerable progress in the advanced studies of their courses of study. In a letter accompanying the volume it is explained that, besides these 75,000 students, more than 225,000 have completed mathematical, physical and other preliminary subjects. The volume is issued to emphasize the fact that in the last analysis the growth of any educational work must depend upon results, and it is confidently believed that this showing of 75,000 students who have actually made good progress with their studies is not only a favorable one, but a really remarkable presentation of the benefits to be derived from correspondence instruction by those unable to attend regular schools. The management of the International Correspondence Schools feel, and we think with justice, that this system has filled what was a serious gap in the educational opportunities of the country.

The American Locomotive Co., 111 Broadway, New York, has issued a pamphlet, "Pacific Type Passenger Locomotives," which describes the Pacific type passenger locomotives built by the company for various railroads; it opens with a description of the type and an outline of its special advantages for heavy and fast passenger service. These advantages, briefly stated, are followed by a description of two forms of trailing trucks which have been used with great success on this type of locomotive. The description is followed by two pages of tables containing in condensed form the leading dimensions of all the locomotives illustrated in the pamphlet; the tables are arranged in the order of the total weight of the locomotives. A typical Pacific type locomotive is illustrated in side elevation and sectional cuts, and cuts of outside and inside bearing trailing trucks are included. The remainder of the pamphlet is devoted to photographic reproductions of locomotives, the opposite pages containing tabular information concerning each design. This is the first of a series of catalogue pamphlets issued by the American Locomotive Co., and it is intended that a series shall eventually include all the standard types of locomotives built by the company and thus constitute a record of their productions.

The American Locomotive Co., 111 Broadway, New York, has issued a compilation by Dr. W. F. M. Goss from the recent publication by the Pennsylvania Railroad, describing the locomotive tests and exhibits of that road at the Louisiana Purchase Exhibition. This pamphlet presents, in concise form, an account of the locomotive tests at St. Louis, giving specific information concerning each of the locomotives tested and presenting the results separately for each of the eight locomotives. In the pamphlet four pages are devoted to a description of each locomotive and a discussion of its performance, including a summary of the data of the tests. This is followed by comparisons and conclusions compiled by Dr. Goss from the very elaborate record of the tests recently issued in book form by the Pennsylvania Railroad. While the pamphlet does not add to the information given in the book, it presents the conclusions and comparisons in form for convenient reference. This pamphlet will give a very wide distribution to a summary of the important records of the testing plant at St. Louis. For a more complete record, the book published by the Pennsylvania Railroad, than which there is nothing more valuable in recent literature of the locomotive, may be consulted. Copies of the pamphlet may be had upon application.

MANUFACTURERS' NOTES.

The Northern Engineering Works, Detroit, Mich., have supplied the Toledo & Chicago Construction Co., Kendallville, Ind., with a 12-ton Northern traveling crane.

The Bown Machine Co., Ltd., Battle Creek, Mich., manufacturers of lathe and planer tools, have recently moved into a larger plant, where they will be in a position to fill all orders promptly.

The firm that has until recently been known as the Norton Emery Wheel Co. has changed its title to the Norton Co. This change was made in view of the fact that the firm no longer uses emery in the manufacture of their wheels, and they felt that the old name was, in a sense, a misnomer.

The Patterson Tool & Supply Co., Dayton, O., and the W. M. Pattison Supply Co., Cleveland, O., on account of the similarity of their titles, are suffering some inconvenience because of misdirected mail. They request that parties communicating with them in the future will take especial care that all letters are properly addressed.

The Toledo Machine and Tool Co., Toledo, O., designers and builders of special machinery, sheet and bar metal-working machines, recently booked among other large orders, an order for a drop-forging equipment consisting of one 10,000-pound, 8,000-pound, 3,000-pound, 2,000-pound, 1,600-pound, 1,500-pound, 1,100-pound, and 1,000-pound trimming presses. They also received another large order for twenty-seven presses ranging in weight from 3,000 to 75,000 pounds, for one of the large electrical manufacturers. Each of these machines is to be direct connected motor driven.

The American Blower Co., Detroit, Mich., issued invitations to the members of the Detroit Engineering Society on May 25 to visit their plant, and to participate with them at a beefsteak dinner to be given at the Fellowcraft Club. After the dinner a regular meeting of the society was held, at which a paper was read by F. R. Still on "Small Vertical High Speed Self-Oiling Engines." The members of the Detroit Engineering Society responded heartily to the invitation. The movement was initiated by the American Blower Co. with the idea that it would be followed by other manufacturers, and thus give the engineers of the city the benefit of the visits to the various manufacturing plants.

The Armstrong Mfg. Co., Bridgeport, Conn., in order to better serve the needs of their increasing Western business, have opened a branch office and warerooms at 23 South Canal St., Chicago, Ill. The new branch is in charge of Hugh S. Laing, formerly assistant manager of the New York City office. In addition to a complete line of genuine Armstrong stocks and dies, there will be carried a full line of Armstrong's pipe cutters, pipe vises, Bard adjustable bushings, ratchet attachments for die stocks and pipe wrenches. A full stock of pipe-cutting and threading machines will be maintained in the wareroom to enable customers in the district to receive their orders promptly. Buyers of pipe-fitters' tools in the West or central part of the country are cordially invited to communicate with the Chicago office for particulars concerning the Armstrong tools.

The General Electric Co., which has recently established its main office in the Union Savings Bank Building, Oakland, Cal., has leased a suite of rooms in the new Monadnock building of San Francisco which they expect to occupy June 15, 1907. For handling their present business they have leased a block of land in Emeryville, in close proximity to both the Santa Fe and the Southern Pacific Railroad tracks. A temporary building for taking care of stock has about been completed, and work has been started on a warehouse to contain 80,000 square feet, located at the south end of the block. Forty cars of material have been housed and nineteen cars of additional apparatus are in the yards waiting to be unloaded. Cars are being shipped from Schenectady and the stock at San Francisco will soon be complete. The company is in excellent condition to fill orders as rapidly as before the fire.

The Crocker-Wheeler Co., Ampere, N. J., have lately received a large number of orders among which might be mentioned: one 450 K. W. 250 volt d. c. generator for the lighting and power of Columbia University; eight 5½ K. W. motor generators for the U. S. Navy gun elevating equipments to Wm. Cramps & Sons Ship and Engine Co., Philadelphia; one 90 H. P. 115 volt, d. c. motor to the Seton Leather Co., Newark, N. J.; three 75 K. W. 250 volt generators for Jos. MacWilliams & Co., Memphis, Tenn.; and equipment for the Lehigh Portland Cement Co., Ormrod, Pa., American Wood-working Machinery Co., Rochester, N. Y.; the M. S. Brown Electric Co., Columbus, O.; the Floyd Wells Co., Royersford, Pa.; Wellman-Seaver-Morgan Co., Cleveland, O. The company have also shipped a carload of their form-L motors, ranging from ¼ to 3 H. P., direct to San Francisco, where they will be used in the rebuilding of the city.

Vol. 4. No. 12 ENGINEERING EDITION Adv. Index Pages 20–23

THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

MACHINERY

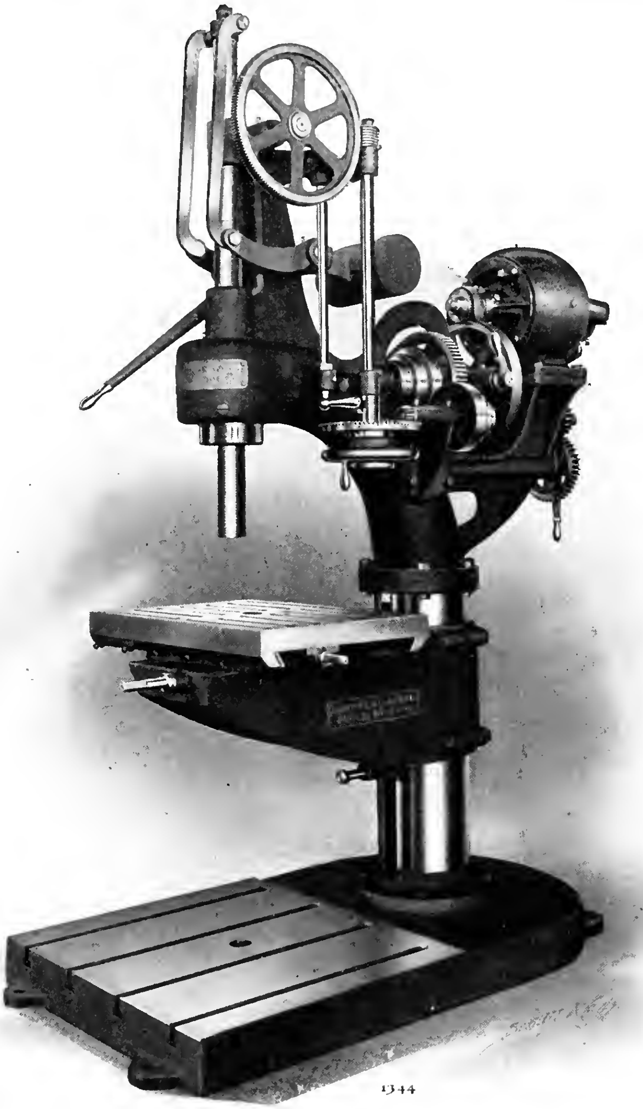
The Industrial Press New York

Regular Edition Vol. 12. No. 12.

August, 1906.

$2.00 a year. 20 cents a copy.

MACHINERY IS THE ONLY MONTHLY IN ITS FIELD. NO OTHER JOURNAL CONTAINS IN EACH NUMBER THE COMPLETE MECHANICAL NEWS OF THE MONTH



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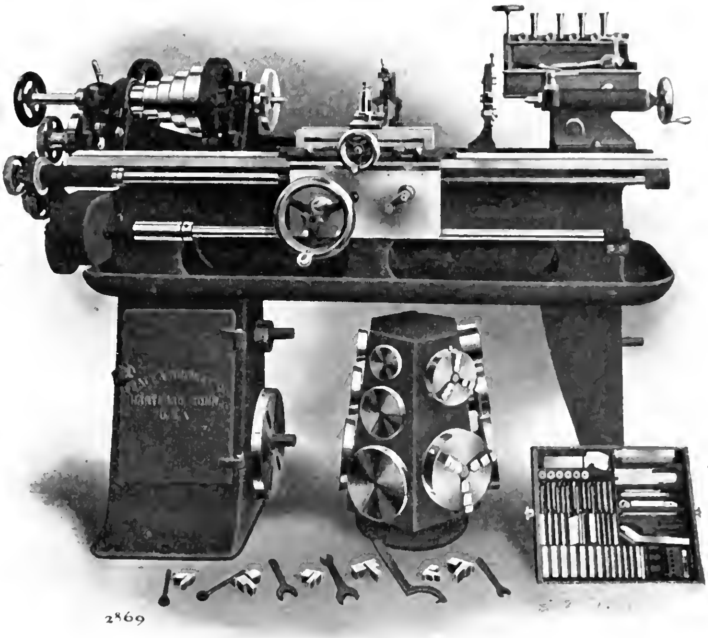
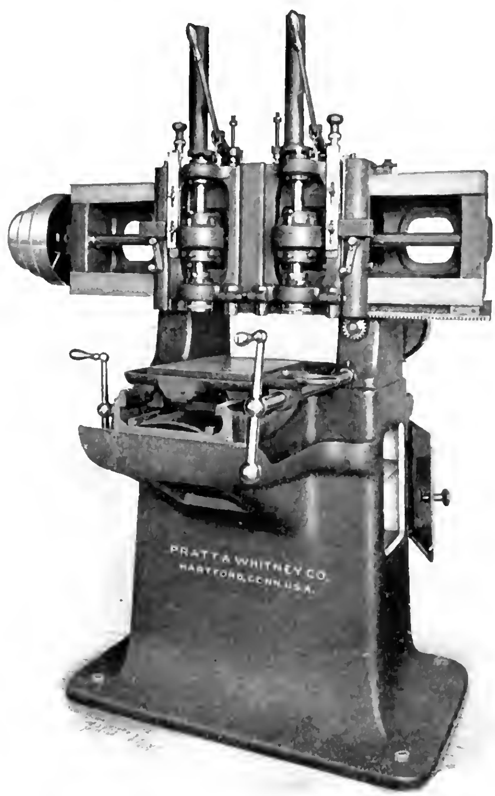


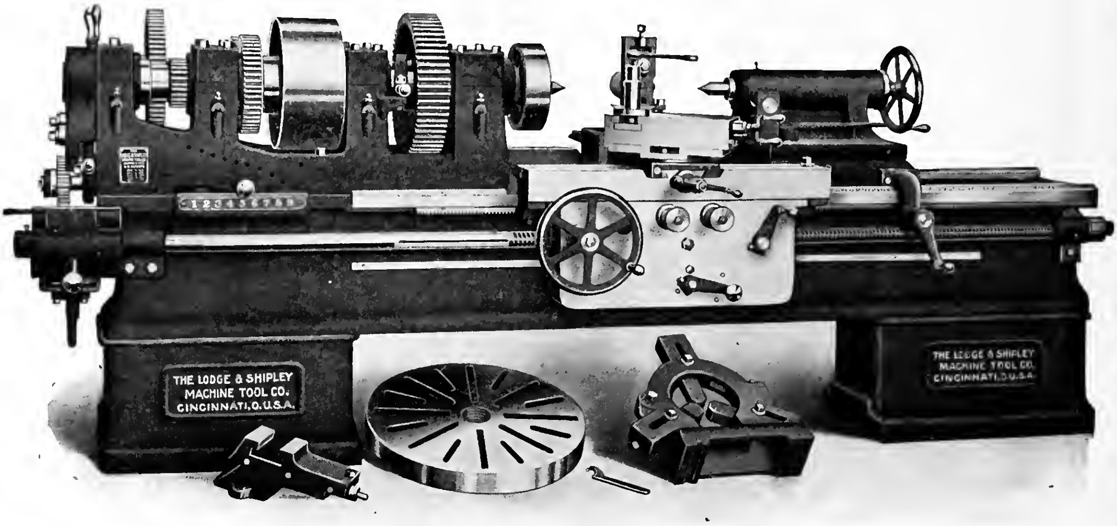
Ten-inch Toolmakers' Engine Lathe with Plain Elevating Rest



No. 12 Two-spindle Profiling Machine

"MORE LATHE WORK WITH FEWER LATHES."

IDLE LATHES



Take a walk through your shop; see if you have any idle lathes; IF SO, WHY?

Is it because they are not adapted to the work to be machined?

In buying the Lodge & Shipley Patent Head Lathe, you buy a lathe that WILL DO EVERYTHING TO BETTER ADVANTAGE than a cone pulley engine lathe of similar size.

Catalogue "R" explains why fully.

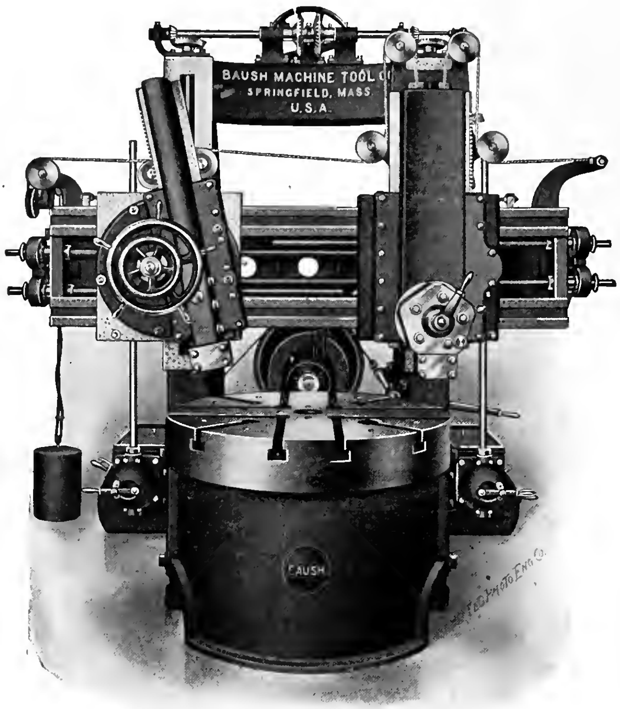
Sizes 14-inch to 48-inch Swing.

The Lodge & Shipley Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

CANADIAN AGENTS—H. W. Petrie, Toronto, Ont. Williams & Wilson, Montreal, Can. EUROPEAN AGENTS—C. W. Burton, Griffiths & Co., London. V. Lowener, Copenhagen and Stockholm. R. S. Stokvis & Zonen, Rotterdam. Alfred H. Schutte, Paris, Cologne, Barcelona, Brussels, Milan. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg. Werner Hult, Helsingfors. Adolfo B. Horn, Havana.

A Rigid and Powerful Boring and Turning Mill for Heavy Work



THE BAUSH 42-INCH BORING AND TURNING MILL takes a prominent place among heavy machines of this type and can be counted on for first-class work in quick time. It is built with one swivel head and one turret head—each entirely independent in its movements both as to direction and amount of feed; either can be brought to the center for boring, and both have a vertical movement of 24 inches. Rigidity of the spindle and table is secured by straight and angular bearings, which, acting in conjunction, relieve the side strains. Any lifting tendency of the table is further counteracted by a thrust ball bearing on the lower step of spindle. Feeds are positive and have 15 changes ranging from $\frac{1}{64}''$ to $\frac{61}{64}''$ horizontally and $\frac{1}{64}''$ to $\frac{9}{64}''$ in angular and vertical directions. All improvements contributing to ease and rapidity of operation, safety, and economical production are incorporated in the design of this machine.

Furnished with two regular swivel heads if desired. Belt or motor drive.

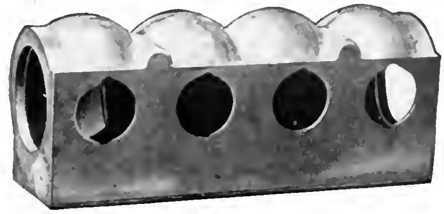
Full particulars will be furnished by the makers.

BAUSH MACHINE TOOL COMPANY

SPRINGFIELD, MASS., U. S. A.

AGENTS—Manning, Maxwell & Moore, Inc., New York, Chicago, Cleveland, Philadelphia, Pittsburg, Boston, St. Louis. DeFries & Cie, Akt. Ges. Dusseldorf, Berlin. DeFries & Cia, Foro Bonaparte 54-56, Milan, Italy. Selig, Sonnenthal & Co., London. Hugo Tillquist, Stockholm. Alfred H. Schutte, Brussels. Takata & Co., Japan.

Automobile Crank Shaft



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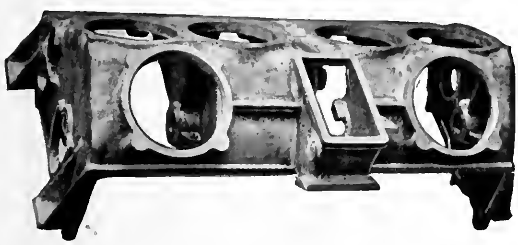
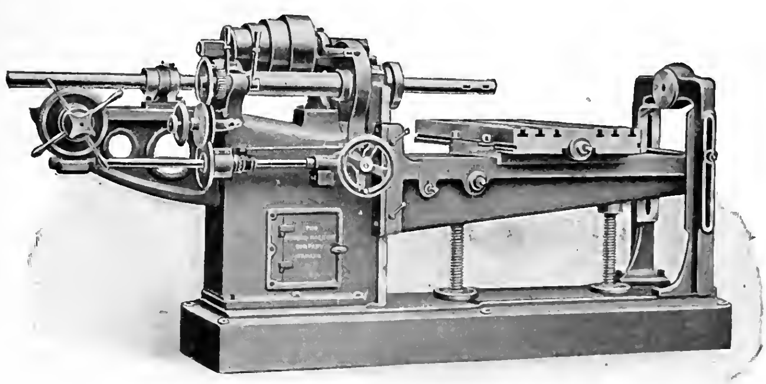


Transmission Cases

Bored quickly without or with a fixture by our



No. 3 Machine

We adapt this machine to meet the exact conditions.

We have also, **other machinery for automobile case boring and milling.**

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AGENTS: CHAS. CHURCHILL & CO., LONDON.
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Hendey-Norton Milling Machines

No. 3 Universal Machine

Feeds, 30 x 10 x 19, *all automatic.*
21 changes of feed, *all positive geared.*

Spindle construction of these machines is our *standard taper journal type*, running in *annular bearings fitted with ring oilers.* Elevating and longitudinal feed screws fitted with ball thrusts.

No. 3 Plain Machine

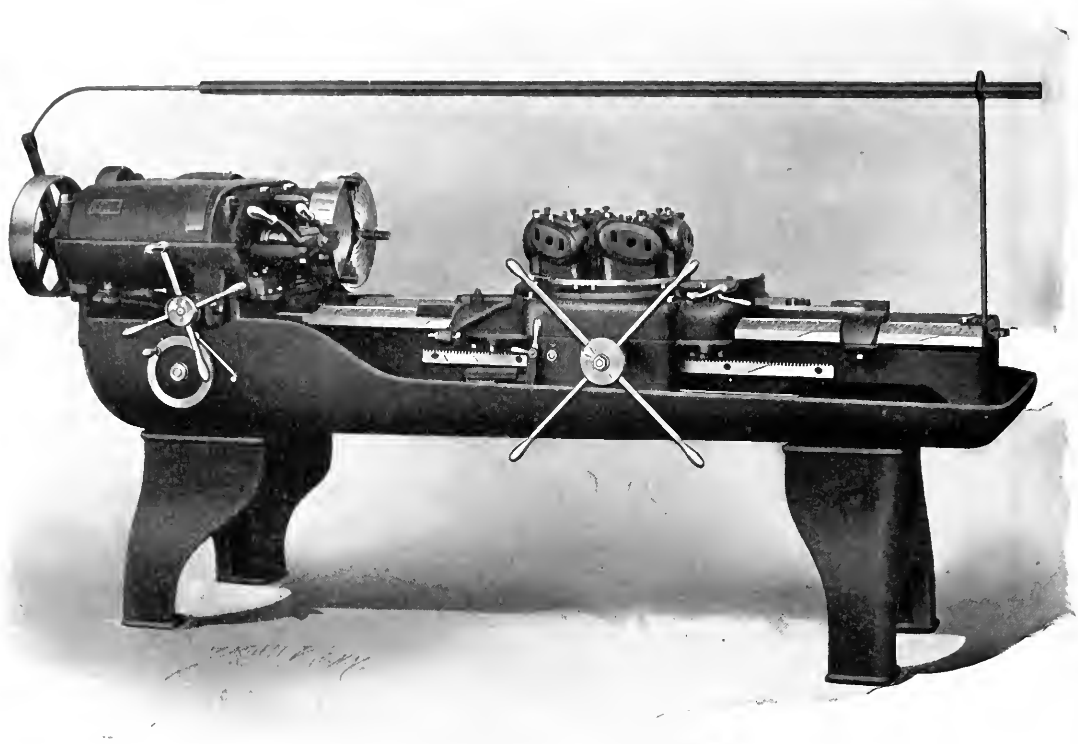
Feeds, 34 x 10 x 20, *all automatic.*
21 changes of feed, *all positive geared.*

Send for illustrated and descriptive matter.

The Hendey Machine Company

Torrington, Conn.

AGENTS: Manning, Maxwell & Moore, Inc., Boston, New York, Philadelphia, Pittsburgh, Chicago. The W. M. Pattison Supply Co., Cleveland. C. W. Burton, Griffiths & Co., London, England. Heinrich Dreyer, Berlin, Germany. Takata & Co., Japan.



Chattering is caused by conditions that are fundamentally objectionable. Every boy knows that he can make a cane chatter along the sidewalk by pushing it ahead at a given angle, and that it will not chatter when dragged at same or any other angle.

The draw-cut shaper astonished many by its wonderful performances of great stock-removing feats, and although this may not be what is primarily wanted in a shaper, it may be cited as an example of the performance of a cutting tool under a pulling cut and non-chattering conditions.

In the lathe, planer, standard shaper and boring mill there seems to be good reason for using the tool mounting that is equivalent to the chattering cane. The expression, "cart before the horse" fits the case, but the plow before the horse would be a better analogy.

In order to offset the chattering tendency in machine tools of thirty years ago, a spring tool was used for finishing cuts which required a tool having plenty of rake. Under the varying strains this tool would yield in opposite direction to its frail mounting: that is, it would spring away from the work under an increased strain, while the slide rests had a tendency to tip over towards the work, which would otherwise cause the tool to "duck in." The yielding of

The Construction of the Flat Turret Lathe Gives a Control of Work and Tools that Greatly Reduces the Tendency to Chatter—

This, in itself, is no mean advantage—it assures accurate work, permits the use of sharper tools with plenty of rake, and broader tools for light and heavy cuts, and dovetails with other improvements that make the Flat Turret Lathe the leader that it is.

The absolute control of tools is attained by the direct and rigid connection of the turret to the carriage, and the carriage to the lathe bed. The head is gibbed directly to the bed by a special system of gibbing which puts the

JONES & LAMSON

Springfield, Vermont, U. S. A.

Germany, Holland, Belgium, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse, 112 Dusseldorf
Blanche, Paris, France. Italy

gib and its thrust taking screws under severe tension, even when adjusted for the free movement of the slide. The object of this is to take up all spring of the bolt and gib before the strain of the work comes on it—a detail of construction, but a detail that counts.

The Flat Turret Lathe is a time saver and a cost reducer on lathe work of all kinds within its range, but especially does it score in duplicate work. It has facilities for handling such work with greater rapidity than other machines, and with a degree of accuracy that is unparalleled. The ten stops for the cross-sliding head combined with the twelve stops for the turret, together with the complete outfit of tools, all of the simplest and stiffest construction, make the machine ready to begin work as soon as it is supplied with power. The turret turns to present each tool to the work, and the travel of the turret carriage lengthwise, with the cross travel of the work carrying head stock, combined with the turning of the turret, bring all the necessary changes of position of work and tools. The Flat Turret Lathe is adaptable, efficient, universal—made in two sizes, 2x24″ and 3x36″, and will effect a saving on your lathe work ranging from 50 to 80 per cent. Write us for particulars.

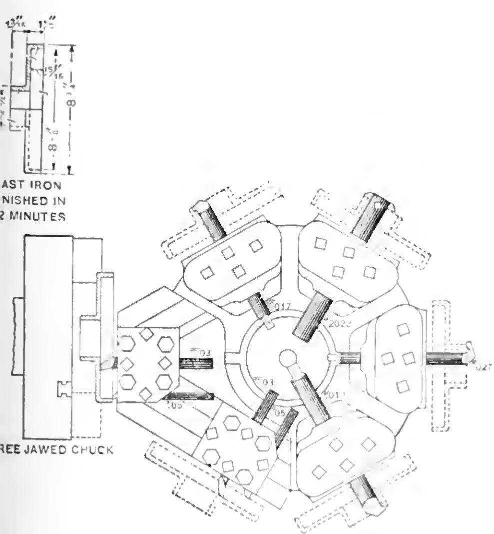
the tool would offset the chattering tendency.

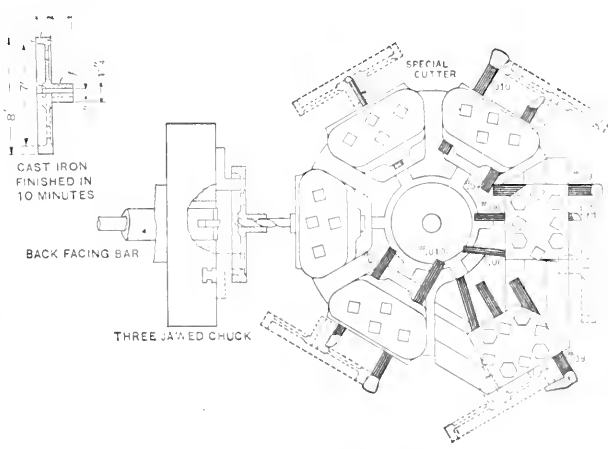
This tendency to chatter has been partly met in present day machines by making all these slides of stiffest form possible, so that it is no longer necessary to use the old fashioned spring tool. But the fact remains, that although we have greatly reduced the chattering, we have yet the plow before the horse and the cane ahead of the boy; that is, the tendency remains, and the conditions exist to a sufficient extent to necessitate the use of blunt tools for heavy chips, and to greatly restrict the use of broad tools for forming taper and irregular cuts.

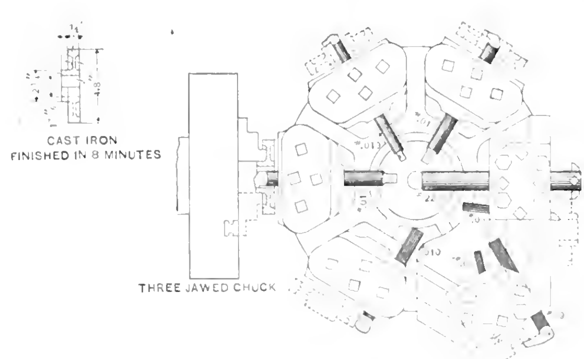
The detailed description and illustrations of the machine described clearly bear evidence of a more perfect control, which is the result of a very low swing, and an absence of long distance control and slide on slide tool mounting.

Inasmuch as the dimensions of work affect the design of machine, that is, a planer must be used for long work, while the shaper is best for short work, from here on we will limit our discussion to the work under 12 inches and 14 inches diameter, for which the flat turret lathe is built.

—Evolution of the Machine Shop







ACHINE COMPANY

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any, France and Spain, Ph. Bonvillain and E. Ronceray, 6 Rue
r & Eisenschitz, Milan, Italy.

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The strong construction, ample weight and high ratio of back-gearing puts the

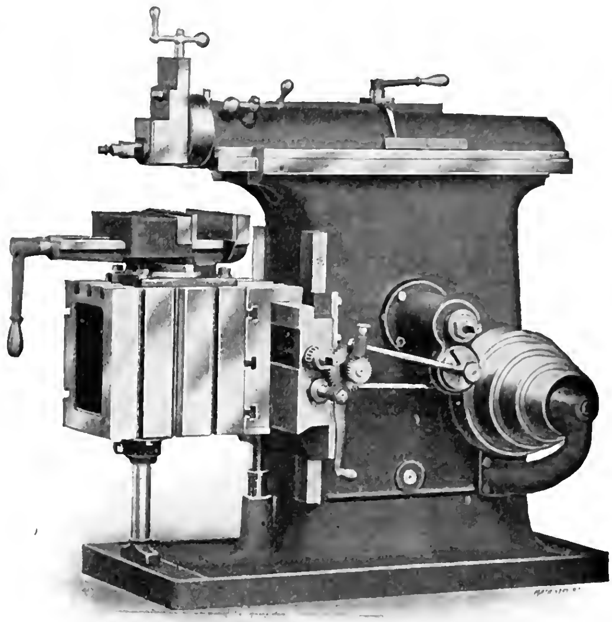
Rockford Shaper

in the front rank as a machine for handling high speed steels.

It will take the heaviest cuts without vibration, and has the power, speed and accuracy essential for modern work.

The gearing in this shaper is so arranged that it can be used single or back-geared, the ratio being 6 to 1 single and 19 to 1 back-geared, with a range of strokes from 8 to 76 per minute.

Full detailed description on request.



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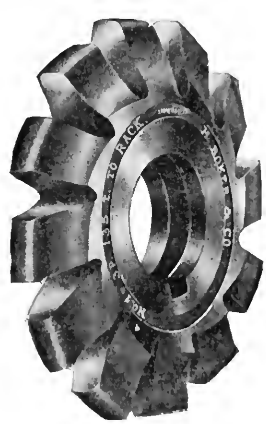
Novo Gear Cutters furnished subject to trial and approval.



We absolutely guarantee all our Novo Gear Cutters.

Send us a trial order. Write for price list with full particulars.

HERMANN BOKER & COMPANY

SMALL TOOL DEPARTMENT

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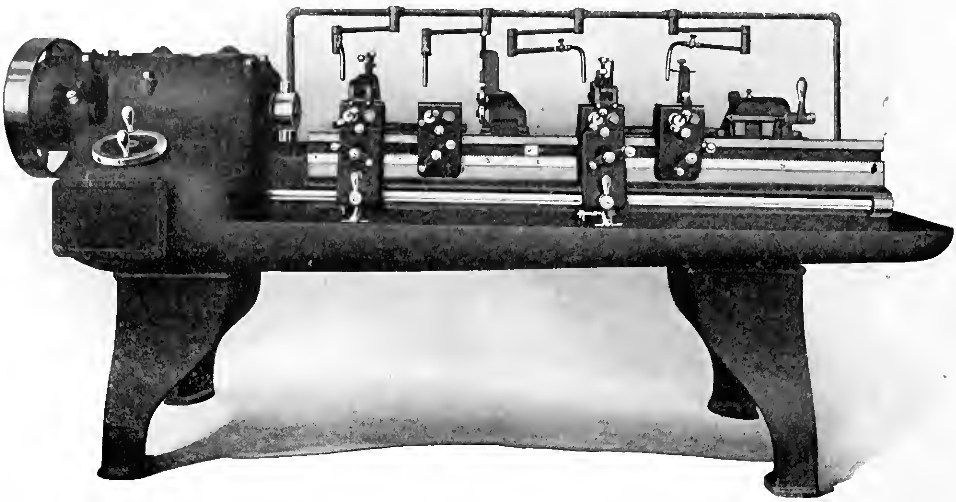
The Lo-swing--the Single Purpose Machine



The demand of the day is for machines with Greater Power, Greater Stability and Greater Productive Capacity. To limit the working range of a machine is to increase its efficiency—hence the single purpose machine, of which the Lo-Swing Lathe is a shining example. *Write for Catalogue.*

BUILT FOR TURNING WORK ON CENTERS ONLY. CAPACITY FROM ½" TO 3½" DIAMETERS, UP TO 60" LENGTHS.

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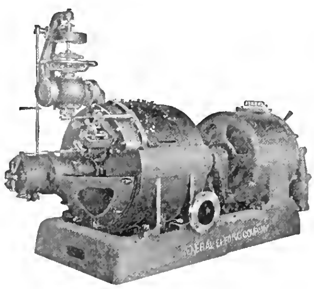
General Electric Company

Curtis Turbine Generators for Direct Current

15 to 300 K. W.



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C-4-75-2400-Form T, 125 Volts.

The turbine is not injured by water drawn from boiler; it may be operated with superheated steam.

No cylinder or other internal oil is used, hence the exhaust steam is perfectly clean and may be used for heating and returned to boilers.

It is easily changed for efficient operation with different steam pressures.

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For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

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Mueller Mch. Tool Co., Cincinnati, O.
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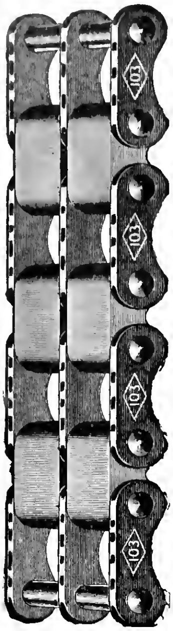
For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 20.



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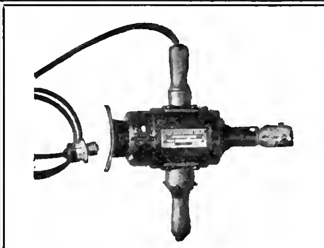

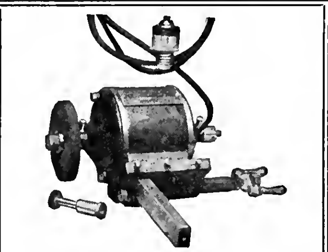

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For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Milling Tools (Hollow Adjustable).
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For Alphabetical Index, see Page 20.

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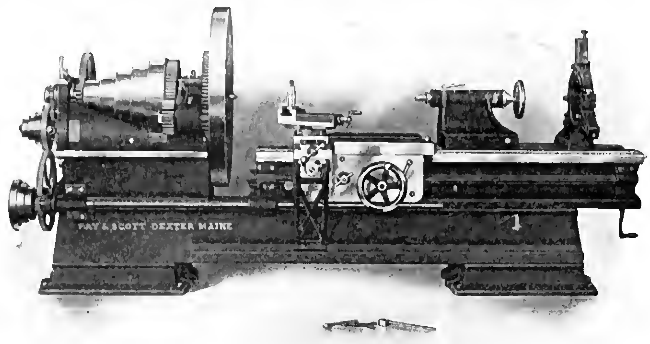

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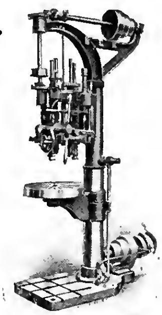

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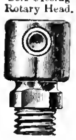

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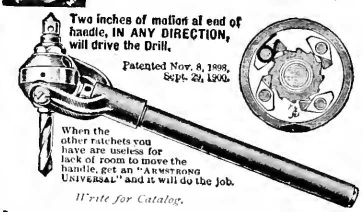

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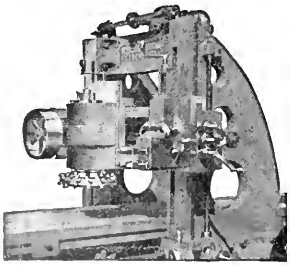

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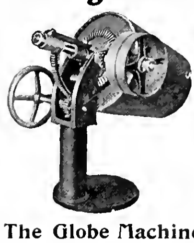

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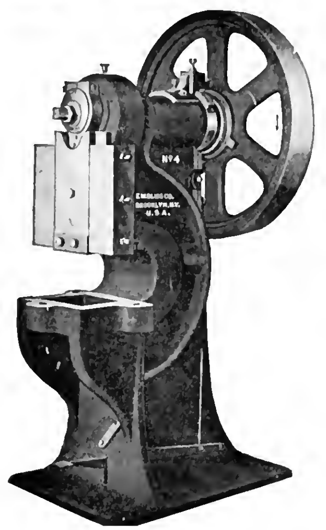

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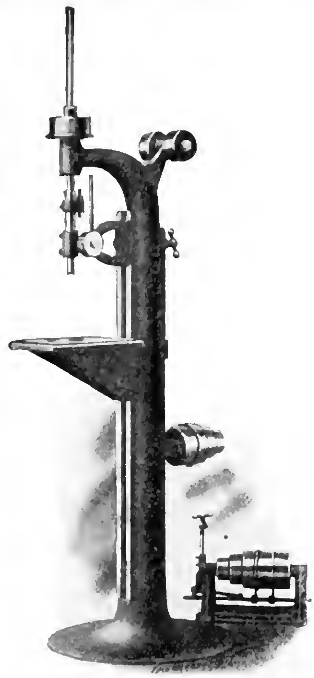

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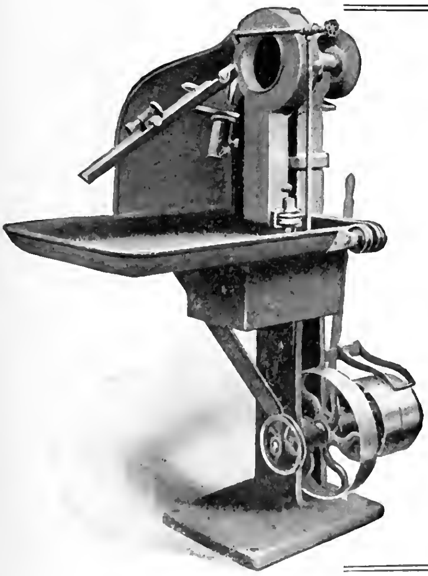

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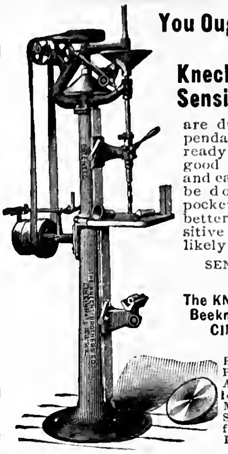

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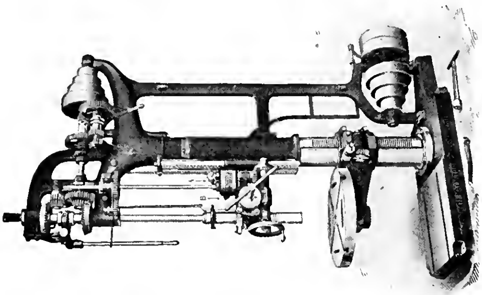

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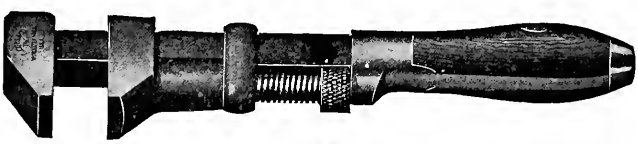

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MACHINERY.

August, 1906.

THE LUSITANIA.

The launching of the new Cunard express steamer *Lusitania* at Clydebank on June 7 last, marks an era in the development of the ocean steamship. Not only has this vessel the greatest tonnage of any yet built or planned, but it is to be the swiftest vessel in the world, outside of the destroyer class, and is to be driven by steam turbines in units larger by far than any that have previously been designed. These engines will develop 70,000 horsepower, an increase of 70 per cent over that developed by the largest and fastest steamer now afloat. This great power is applied to quadruple screws, still another innovation in steamship design. Considerations of national pride were largely instrumental in deciding upon the building of the *Lusitania* and her sister ship, the *Mauritania*. English vessels had held the supremacy for speed up to about nine years ago. At that time the Hamburg-American Line, with the encouragement and assistance of the German government, built and put in commission the *Kaiser Wilhelm II.*, the fastest of a series of large and powerful vessels which have ruled the seas from that time to this. This increase in power and speed of the German boats, coupled with the absorption of a number of the English lines by the American capital of the "steamship trust," led to the belief on the part of the British government that their marine supremacy was endangered, and that there would come a time when the Admiralty would be handicapped in time of war by a lack of the merchant flyers on which they have been accustomed to depend in making their estimates of the nation's naval strength. Thus national pride and national safety combined to urge the government to assist the Cunard Co. in the building of these two 25-knot steamers.

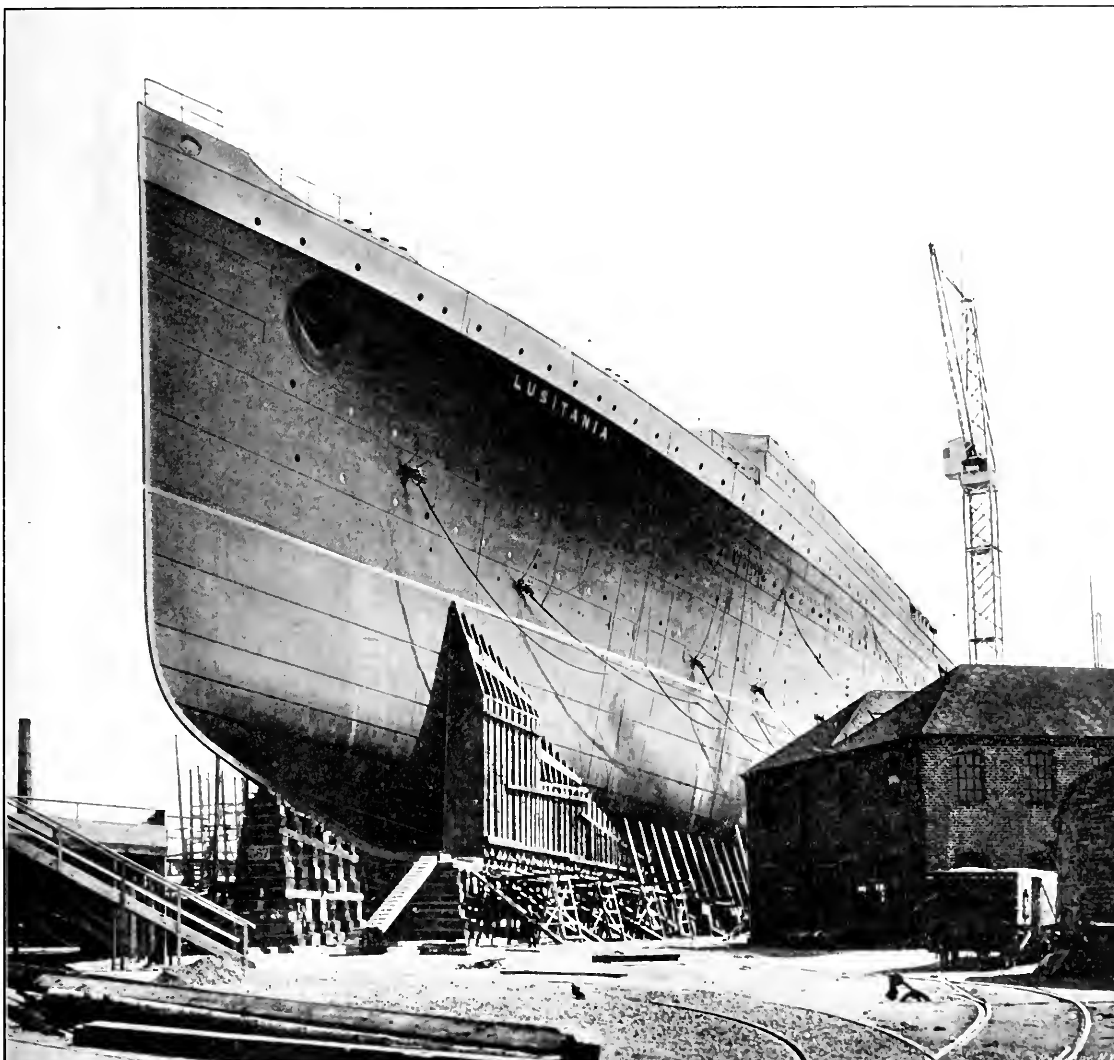


Fig. 1. Bow View of the "Lusitania," on the Waye Ready for Launching.

Sir Andrew White, naval architect, who had a large share in determining the design of the new vessels, in a recent letter to the *London Times* has described the thorough and painstaking way in which decisions were reached on the engineering questions involved. The main considerations were that these vessels should be "capable of maintaining a *minimum*

average ocean speed of from 24 to 25 knots in moderate weather." On this condition depended the payment of an annual subsidy from the government, and important financial arrangements in regard to raising the necessary capital. The idea that the vessels were to be available as powerful cruisers in time of war was also a determining factor in planning their equipment. With these points in mind, and with the tonnage of the vessels determined, the best engineering ability of the country was employed in outlining the design. No unusual steps were taken without first carrying out exhaustive experiments to determine their feasibility. These experimental inquiries were combined with scientific calculations, and every precaution was taken to obtain the best results as regards form, dimensions, economical propulsion, strength, stability, good behavior, passenger accommodation, and efficient working of the propelling apparatus. Proposed models for the hull were tried out in the model tank of the Admiralty at Haslar and at the works of the builders.

When the question of deciding on the type of motive power and propelling apparatus was reached, the directors of the Cunard Co. appointed a special committee for the purpose of considering and reporting on the possible adoption of turbine machinery. The committee included representatives of the Cunard Co., the Admiralty, Lloyd's, and the firms who were to build the boats. A member of Messrs. Denney & Co., who have had exceptional experience in the construction of turbine steamships, also gave his services in the discussion of this question. Mr. Parsons and his staff prepared the designs which were submitted to the committee.

To obtain the increase of speed from the 23½ knots of the fastest German liner to the 25 knots proposed for these vessels, required a much greater proportional increase in power plant than that required in passing from 22 to 23½ knots. It was discovered that the increase of engine power, as noted in the introductory paragraph, would have to be about 70 per cent over that of the *Kaiser Wilhelm II.*, with a corresponding increase in the coal consumption and coal storage space. In considering the adoption of reciprocating engines it was found that triple screws and three sets of machinery would be necessary, and that each set would have to be of much greater power than any engines previously built. One unit would have had to be set behind the other two. With engines of large power set so far aft, even with the most careful balancing, there would be risk of objectionable and dangerous vibration. Besides this, the making of the propeller and crank shafts would involve great difficulties, as they would be heavier than anything hitherto attempted. After making trials of two sister ships built by Messrs. Denney & Co., of which one was fitted with turbines and the other with reciprocating engines, the results were so favorable to the turbines, and this form of apparatus gave so complete a solution to the problem just outlined, that it was finally determined to use this new type of apparatus even though it involved an increase in power of nearly five times that of the largest engines of this type previously built. This abrupt increase in power was practically as great as the total advance made gradually with reciprocating engines in the past forty or fifty years, yet the committee has perfect confidence that the design as finally approved will be a practicable one, since every feature has been so carefully studied that in no detail can these engines be said to involve experimental or undetermined factors. The advantages it is expected to gain by the use of the turbine are: Freedom from vibration; reduced cost of maintenance and working expense; greater economy in the use of steam at or near the maximum power; capacity to run continuously for long periods without sensible deterioration in condition; and power to take considerable overloads without injury. The available evidence also shows that the turbine tends to increase in economy with increase in size and power.

In Fig. 1 is shown a view of the bow of the *Lusitania* as she appeared on the ways in the shipyard of Messrs. John Brown & Co., just previous to the launching. The great size of the hull is realized on comparing it with the buildings that stand beside it. The hull is 785 feet long over all, with an extreme breadth of 88 feet and a depth of 60½ feet. This proportion of length to breadth is not so great as in other recently designed trans-Atlantic steamers. The water-line length of the *Lucania* is 9.2 times the beam; of the *Oceanic*, 10 times the beam; of the *Kaiser Wilhelm II.*, 9.5; while that of the new Cunarders will be only 8.6 times the beam. This great length with greater proportionate beam, favors economical propulsion at maximum speed. Her lines gradually widen out to the full beam, and from this point fall away again to the stern, thus giving no continuance of the greatest width on the water line. She is thus all " entrance" and "run". A notable increase in proportionate depth has been made, which favors the longitudinal strength of the vessel when exposed to the vertical bending action of Atlantic storm waves. The proportion of length to depth is about 12.6 as compared with 13 and 14 for other large and fast vessels.

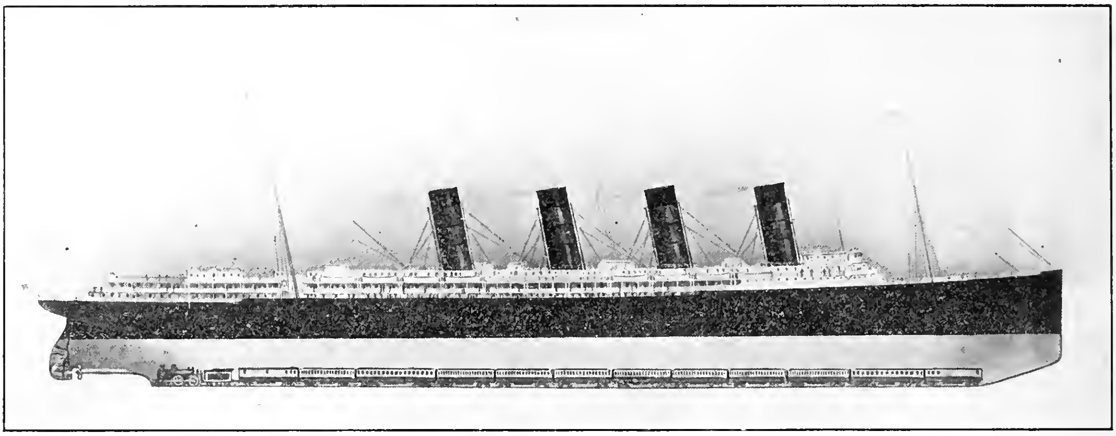


Fig. 2. Comparative Lengths of the "Lusitania" and the "Cunard Special" Express.

The keel is about five feet high and one inch thick, and does not project through the bottom of the hull. This keel, together with the numerous transverse frames, divides the double bottom into compartments in which water ballast may be carried. The tops of these tanks are carried well beyond the turn of the bilge so that any injury to the hull due to collision below water line or grounding, will be confined between the inner and outer bottoms. Bilge keels are provided to insure steadiness of behavior. The lower deck is made completely water tight. Below it are the lower orlop and orlop decks and above it are the main, upper, shelter, promenade, and boat decks, nine decks in all; the decks below the water line are all divided into water-tight compartments which may be closed by bulkhead doors of special design, operated automatically from the bridge. The vessel will have in all 175 water-tight compartments thus protected.

There are 25 boilers of the usual cylindrical or Scotch type, all but two of which are double-ended. The steam pressure is about 200 pounds per square inch. There will be four funnels 24 feet in diameter, with tops 155 feet about the keel. The fur-

naces will consume about 1,000 tons of coal per 24 hours during the transatlantic passage and great care has been taken in arranging the coal bunkers so that this great weight may be handled with economy of time and labor. The question of oil fuel was considered and if it had been possible to obtain a reliable supply of a suitable fuel of this kind, the problem of handling and storing fuel would have been greatly simplified. If it is warranted in the future, however, the change from coal bunkers to oil tanks can be readily made. Electricity will be largely used for the lighting, ventilation, operation of elevators and other auxiliary purposes. The current will be generated by steam turbines instead of the reciprocating engines usually employed.

As already mentioned, the motive power is divided into four units, each of which has its own propeller shaft and propeller. The two outer shafts carry the high pressure turbines, the inner shafts the low-pressure and backing turbines, thus making six in all, four for forward and two for backward motion. The shafts and rotor drums for these engines are of immense size and strength and were forged at the Atlas Works of the builders at Sheffield. The longest blades on the low-pressure rotor, those at the exhaust end of the machine, are 20 inches in length. The speed at the periphery of the circle formed by the blades ranges from 100 to nearly 150 feet per second. The casings and blades for one of the low-pressure turbines weigh about 450 tons complete. The placing of the propellers was a new problem and one determined only after considerable investigation and experiment; as built, the high-pressure pair are located about 80 feet forward of the low-pressure propellers, and are carried by long, tapering tubes which support them at quite a distance from the sides of the hull. In the general arrangement of the propelling machinery the Cunard Co. has been greatly assisted by its experience in the building and operation of the *Carmania* and the comparison of the performance of that vessel with her sister ship, the *Coronia*, which is fitted with reciprocating engines.

It has been mentioned that the vessel was designed with a view to being used as a cruiser in time of war. For this purpose her coal bunkers have been so arranged as to protect the vital parts of the machinery. The rudder and its supporting framework is entirely below the water line, and is provided with two sets of steering gear, one of which is also below the water line. Provision has been made in the framing and deck arrangements of the vessel for the housing of twelve 6-inch guns, which will compose the offensive armament.

The great length and draft of the vessel necessitated unusual preparations for her launching. The keel was laid down in such a direction that the hull took the water at the widest available point, giving not only the width of the River Clyde itself but a considerable space in the mouth of a tributarial stream, the Cart, which flows in at this point. Dredges have been constantly at work for a number of months to make ready a launching channel for the big vessel. To bring her to a stop within the length of run which it was possible to provide, sixteen masses of chain cable were used to check the momentum after launching; each pile of cable weighed one hundred tons. As the vessel slid down the ways into the water these chains, connected to the hull by wire cables, came into action pair by pair until five pair finally stopped her career, the last of them being scarcely tightened. The launching weight of 16,000 tons was by far the heaviest weight ever carried upon the launching ways of any shipyard, but the operation was effected without difficulty and without danger. It will probably be a year or more before the *Lusitania* will be in commission

Perhaps a comparison will serve to convey a clearer idea of the immense size of this largest and fastest of all ocean steamers. Fig. 2 shows the "Cunard Special" express train which runs between London and the landing stage of the steamship company in Liverpool. This train, with its powerful engine, tender, two baggage cars, two dining cars and eight coaches, is fully 100 feet shorter than the *Lusitania*. The funnels will be 155 feet, and the tops of the masts 216 feet above the keel. The gross tonnage of the vessel is 32,500, while her displacement, when filled with her cargo, will be fully 45,000 tons.

BRAKES.—1.

C. F. BLAKE.

The duty of a brake applied to machinery is to absorb energy by creating frictional resistance, which must transform into equivalent heat a certain number of foot-pounds of energy in a given time.

This leads at once to an important function of any brake, often overlooked; it must be designed to convey away the heat as rapidly as possible by conduction, radiation and convection by the air. This means that the friction must be distributed over a sufficient area to prevent undue heating of the parts for the material of which they are made.

The most severe duty exacted of crane brakes is found in traveling cranes, where the brake is often called upon at such frequent intervals as to allow a minimum time between for cooling. Indeed, these brakes often run for long periods at temperatures exceeding that of the atmosphere.

Brakes with wood friction blocks on iron drums give satisfactory service if one square inch of friction surface is allowed for each 200 or 250 foot-pounds of energy absorbed. Car brakes, on the other hand, running with iron on iron under conditions very favorable to quick cooling, are often called upon to absorb as much as 10,000 to 15,000 foot-pounds of energy per square inch of friction surface. Figures for other types of brakes will lie between these extremes.

It has been the practice with some designers to provide a ribbed exterior to the casing of block brakes, and also to use thin ribs or vanes on the brake drum to provide radiating surface. It is also customary to leave all radiating surfaces rough and black, since a finished or polished surface confines the heat instead of radiating it into the atmosphere. The location of the brake on the crane is also of importance in regard to cooling, since if placed in a protected position it will not cool as rapidly as if more exposed to the air currents.

The mechanical equivalent of the heat required to raise one pound of water through one degree Fahr. is 778 foot-pounds of energy. Kent, page 475, quoting Box on Heat, gives values for the heat units radiated per hour per square foot for each degree Fahr. rise in temperature; and these figures reduced to square inches per minute per degree rise in temperature are:

Cast iron, new	0.000075
Cast iron and sheet steel, rusted	0.000079
Sheet iron, polished	0.0000106
Sheet iron, ordinary	0.000066
Wood	0.000085

The equivalent foot-pounds of energy radiated are these figures multiplied by the mechanical equivalent 778, giving us the radiation constants R for

Cast iron, new	0.058	R
Cast iron and sheet steel, rusted	0.061	
Sheet iron, polished	0.0082	
Sheet iron, ordinary	0.051	
Wood	0.066	

which latter figures are the foot-pounds of energy radiated per square inch of surface per minute per degree rise in temperature, according to Newton's law of cooling, which is that the radiation is proportional to the difference in temperature $(t_1 - t)$ between the radiating body and the air.

This law has been proved incorrect beyond the limits of a difference in temperatures of thirty degrees, with the atmosphere not higher than sixty degrees Fahr. Kent gives the following table as computed by Box, for correcting the radiation constant R beyond these limits.

TABLE I. CORRECTION FOR RADIATION CONSTANT.

$t_1 - t$ Fahr.	Temperature of the Air t.				
	32	50	59	68	86
18	1.00	1.07	1.12	1.16	1.25
36	1.03	1.08	1.16	1.21	1.30
54	1.07	1.16	1.20	1.25	1.35
72	1.12	1.20	1.25	1.30	1.40
90	1.16	1.25	1.31	1.36	1.46
108	1.21	1.31	1.36	1.42	1.52
126	1.26	1.36	1.42	1.48	1.60

The loss by convection appears to be independent of the material of the heated body, but varies with its shape and location, and for any given conditions is nearly proportional to the temperature difference. This proportion, however, like that for radiation, needs adjustment beyond narrow limits, and Kent presents a table similar to the above for convection losses; but the extreme variation in shape and location, in the case of brakes, leaves the designer so few data as to render the table practically useless for this purpose. The best values obtainable for convection losses indicate that they may be taken at about three quarters of the radiation losses, making the total loss 1.75 × the loss by radiation.

The specific heat, or more properly, the coefficient of thermal capacity, of various materials used as friction surfaces in brake construction, compared to water as unity, is as follows:

Brass, 0.094
Wrought iron, 0.114
Cast iron, 0.130
Steel, 0.117

The foot-pounds of energy required to raise one pound of these materials one degree Fahr. is then, 778 × the specific heat, which gives for

Brass, 73
Wrought iron, 88
Cast iron, 101
Steel, 91

These values we will designate by c.

With wood or leather blocks 150 degrees Fahr. is set as a limit if charring of the blocks is to be avoided, while with metal friction blocks the temperature is limited by the ability of the parts, especially the drum, to withstand the accompanying expansion without cracking. To aid the drum in this respect the web or arms are often made dished, which gives them a slight elasticity, enough to accommodate the expansion of the drum under the confining influence of the blocks.

The arms and hub of the brake drum are so remote from the friction surface as to acquire heat by conduction very slowly, and this source of loss may be neglected.

Let

W = the weight of the brake drum rim in pounds,
c = foot-pounds of energy required to raise one pound one degree Fahr. (values given above)
R = radiation constant (values as given above. Use $1.75R$ to allow for convection)
A = the area of the radiating surface, in square inches.
n = the number of minutes elapsing between the applications of the brake,
t_1 = the maximum temperature of brake drum at moment of attaining rest, Fahr.
t = the minimum temperature of brake drum, after cooling from t_1 for n minutes, Fahr.
E = foot-pounds of energy to be absorbed at the brake.

We then have (see *A Laboratory Manual of Physics*, by Prof. E. L. Nichols)

$$\log\ (t_1 - t) = \frac{0.437\, n\, R\, A}{W\, c} \qquad (1)$$

from which, by a table of logarithms, the value of $t_1 - t$ may be found.

Now $t_1 - t$ is the raise in temperature, so

$(t_1 - t)c$ = foot-pounds absorbed in raising one pound from t to t_1 degrees Fahr.

But we have a total of W pounds, so the total foot-pounds absorbed is,

$$E = (t_1 - t)\, c\, W \qquad (2)$$

Therefore,

$$t_1^\circ = \frac{E + t\, c\, W}{c\, W} \qquad (3)$$

and,

$$(t_1 - t) = \frac{E}{c\, W} \qquad (4)$$

By these formulas the performance of a given brake as regards heating may be approximately determined, but as will be observed, much is left to the judgment of the designer in their use.

Classes of Brakes.

Crane brakes are usually found to be in one of three classes:

I. Band brakes, consisting of a flexible band wrapped around the periphery of a drum;

II. Block brakes, consisting of arms carrying blocks arranged to clamp the drum between them;

III. A third class, which from the method of application should be called axial brakes, since they are applied in a direction parallel to the shaft, but which are variously spoken of as friction brakes, load brakes, safety brakes, automatic brakes, and mechanical brakes.

Brakes of this class are usually designed so that the retarding torque is directly proportional to the load sustained, and are most largely used on electric and hand cranes for the automatic sustaining of the load should the power fail. We, therefore, prefer the name automatic brake for this class, although this must not be assumed to mean that either of the other two classes of brakes cannot be made to act automatically under certain conditions.

Brakes of the first two classes present no great difficulties to the designer, but of the third class, automatic brakes, it may be said that there is perhaps no part of the modern crane offering the difficulties presented by this mechanism.

The variation of the coefficient of friction under varying conditions of load, speed, temperature, lubricants, materials and finish of friction surfaces, compels at the start an assumption that may be more or less wide of the mark. Other conditions, more or less important according to the design of the brake, are the action of centrifugal force, the unequal wear of the friction surfaces, the expansion and contraction due to heating and changes of atmospheric temperature. All these render the final performance of a given brake so much a matter of conjecture that it is unwise to depend upon calculations in this regard.

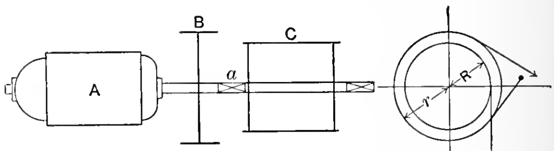


Fig. 1. Simple Problem in Finding Kinetic Energy.

All such brakes should be designed as far as possible with facilities for changing conditions, such as altering the diameter or number of the friction discs, changing the pitch of the helix or thrust screw, as experiment with the completed brake may direct.

A thorough investigation of the behavior of these brakes is much needed, and offers an interesting and profitable field for thesis work in some well-equipped mechanical laboratory. Lacking such investigation, the designer, working out an occasional brake, should provide ample facilities for such final changes as the test load behavior of the brake may suggest.

In designing a set of brakes for a line of cranes of varying capacities, an experimental brake should be made and tested, changes being instituted until the test behavior of the brake is satisfactory, and the entire set of brakes carefully proportioned from these data. Even this procedure is not entirely satisfactory. A set of brakes was thus designed by a manufacturing company for a line of cranes ranging from three to seventy-five tons capacity, and all were found to work satisfactorily with the exception of two. Upon examining these for differences or irregularities in their proportions, as deduced from the experimental brake, none were found, and their peculiar behavior could only be charged to the uncertainty of the many varying factors.

Formulas (1) to (4) require that the kinetic energy to be absorbed by the brake be known, and this is made up of four factors: the energies of the live load; of the rotating parts; of the parts having a motion of translation; and the energy preventing acceleration.

Let us consider first the energy of the live load and that preventing acceleration. Let Fig. 1 represent an elementary crane consisting of motor A, brake B, and drum C, all mounted upon a single shaft. Let it be assumed that the brake is

so proportioned as to just hold the suspended load in equilibrium. Then the suspended load possesses potential energy, and the tangential force or friction at the brake drum rim required to hold the load is

$$F = \frac{W\,R}{r}$$

if we, for the time, neglect all frictional losses.

Let n = the revolutions per minute of the motor. Then if the motor be started in the lowering direction, the velocity V of the descending load will be known, since by reason of our assumption, the brake prevents acceleration. Hence,

$$V = \frac{2\,\pi\,R\,n}{60 \times 12}$$

feet per second, if R is in inches.

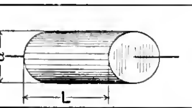
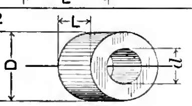
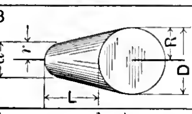
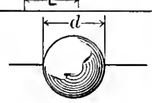
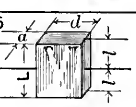
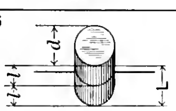
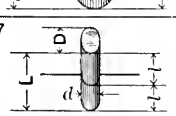
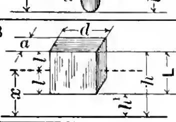
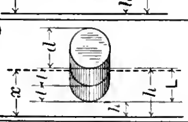
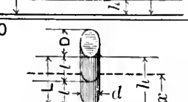
The energy of the descending load is then,

$$E = \frac{W\,V^2}{2\,g} \qquad (5)$$

g being 32.2.

If the load were to be lowered free, and unrestrained by any brake it would obey the laws of gravitation, and, overhauling the motor, would descend with a constantly accelerating velocity. It therefore follows that there is work done in overcoming this acceleration and confining the load to a constant velocity, and that this work is done by the brake, and is represented by the friction times the relative velocity of the frictional surfaces. Usually one friction surface is at rest, and the relative velocity becomes the velocity of the other.

TABLE II. PROPERTIES OF BODIES OF ROTATION.

	VOLUME	k^2
1 	$\frac{\pi}{4}\,d^2\,L$	$\frac{d^2}{8}$
2 	$\frac{\pi}{4}\,L\,(D^2 - d^2)$	$\frac{D^2 - d^2}{8}$
3 	$\frac{\pi}{12}\,L\,(D^2 + Dd + d^2)$	$\frac{3}{10}\left(\frac{R^5 - r^5}{R^3 - r^3}\right)$
4 	$\frac{\pi\,d^3}{6}$	$\frac{d^2}{10}$
5 	$a\,d\,L$	$\frac{a^2}{12} + \frac{l^2}{3}$
6 	$\frac{\pi}{4}\,d^2\,L$	$\frac{d^2}{16} + \frac{l^2}{3}$
7 	$\frac{\pi}{4}\,D\,d\,L$	$\frac{D^2}{16} + \frac{l^2}{3}$
8 	$a\,d\,L$	k^2 (from 5) $+ x^2$ $\frac{d^2}{12} + \frac{h^2 + h\,h' + (h')^2}{3}$
9 	$\frac{\pi}{4}\,d^2\,L$	k^2 (from 6) $+ x^2$ $\frac{d^2}{16} + \frac{h^2 + h\,h' + (h')^2}{3}$
10 	$\frac{\pi}{4}\,D\,d\,L$	k^2 (from 7) $+ x^2$ $\frac{d^2}{16} + \frac{h^2 + h\,h' + (h')^2}{3}$

Machinery, N.Y.

This velocity is,

$$V' = \frac{2\,\pi\,r\,n}{60 \times 12} \text{ feet per second,}$$

and the kinetic energy is,

$$E_a = \frac{F\,(V')^2}{2\,g} \qquad (6)$$

in which F = the friction at the brake wheel rim.

In bringing the load to rest upon shutting down the motor, the brake is called upon not only to absorb or turn into equivalent heat the kinetic energy from these two sources, but also

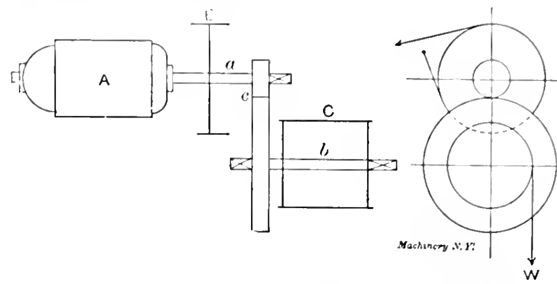


Fig. 2. Finding Energy of Rotating Parts, including Gear Train.

the kinetic energy of all rotating parts, since these must also be brought to rest.

The kinetic energy of a revolving body is,

$$E_r = \frac{2\,\pi^2\left(\frac{n}{60}\right)^2 k^2\,W'}{g} = \frac{W'\,\pi^2\,n^2\,k^2}{1800\,g} \qquad (7)$$

in which,

n = rev. per minute of the motor,

W' = weight of revolving parts, in pounds.

k = radius of gyration of body in feet, about axis of rotation.

The following table gives the properties of different elementary bodies, and in order to arrive at a value for E_r, we must divide each body of rotation on the shaft into some one or more of these elementary bodies, and finding the kinetic energy of each such elementary body by (7), take their sum as a value for E_r.

In dividing several rotating bodies into their elements for use as above, a drum, for instance, may be considered as made up of case (2) for the shell, flanges and hubs, and case (8), (9) or (10) for each arm, according to the shape. In this manner any complex rotating body may be divided, and its kinetic energy approximately determined.

In Fig. 1, there is no motion of translation, but this is often present in the shape of a moving trolley, bridge or portable crane. It is most frequently unaccompanied by the hoisting or lowering of the load, although in rare cases one brake may be used to bring to rest both a lowering lead and a moving trolley.

The kinetic energy of a body having motion of translation is,

$$E_t = \frac{W''\,(V'')^2}{2\,g} \qquad (8)$$

where W'' = the weight of the body in pounds,

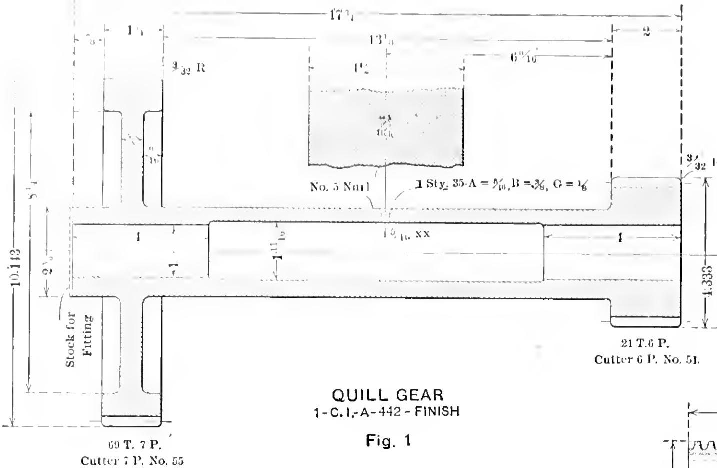
V'' = its velocity in feet per second.

Thus in Fig. 1, the total kinetic energy to be absorbed by the brake is,

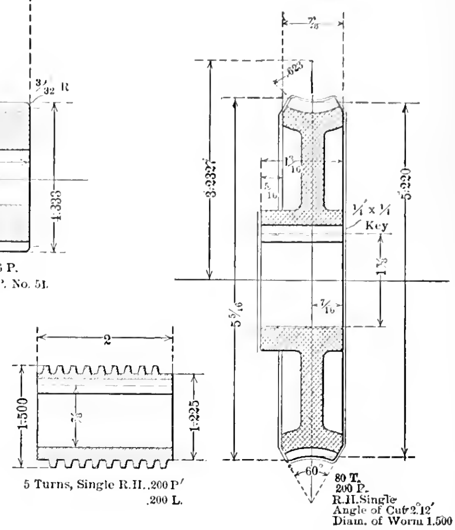
$$E_{total} = E + E_a + E_r. \qquad (9)$$

and in calculating the value of E_r, the motor armature, shaft, brake drum, and hoist drum are considered.

While Fig. 1 makes a good illustration of the above principles, it still leaves unconsidered the effect of internal frictional resistances in the machine, which, by absorbing a certain amount of energy, relieve the brake of a portion of its work. In other words, the total kinetic energy E_{total} is not absorbed by the brake, but only a portion $e\,E_{total}$, where e is a decimal, the remainder being absorbed by the internal fric-



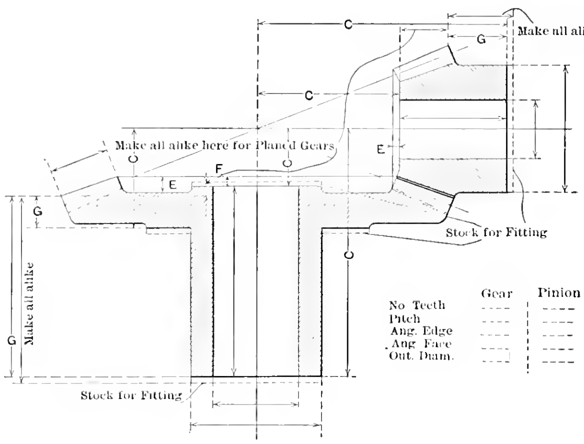
QUILL GEAR
1-C.I.-A-442-FINISH
Fig. 1



WORM
1-M.S.C.H.

WORM WHEEL
1-G.M. F-2-A / 13

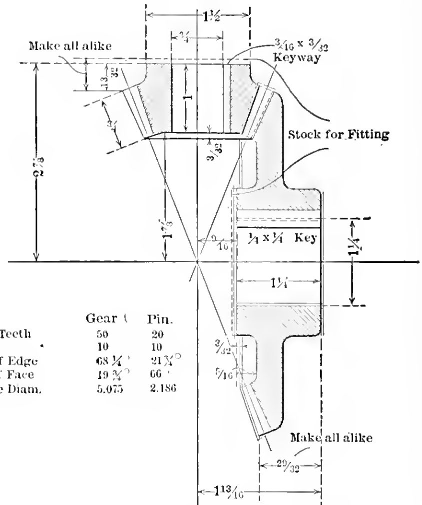
Fig. 5



	Gear	Pinion
No Teeth	----	----
Pitch	----	----
Ang. Edge	----	----
Ang. Face	----	----
Out. Diam.	----	----

Figure E and F as near as can be measured easily on the drawing.
If rough on end of Hub and front of Gear, give only one dimension.
Figure C to either the outside or inside Hub of Gear to check with other details.
Never give but one dimension C for the same Gear.
Figure G to the nearest even figure not finer than 1/32. Give figure to the Shoulder that is worked from. Give but one dimension G for same Gear.
Leave Stock for fitting only at Shoulders when required and indicate as shown on drawing.
In giving Angles give nearest 1/4 degrees.

Fig. 3



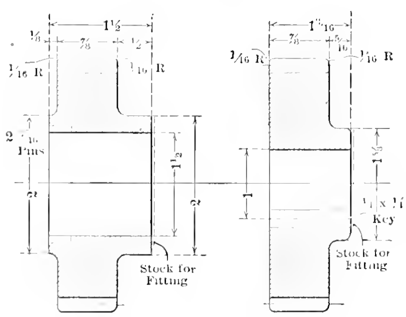
	Gear	Pin.
No of Teeth	50	20
Pitch	10	10
Ang. of Edge	68 1/4°	21 3/4°
Ang. of Face	19 3/4°	66°
Outside Diam.	5.075	2.186

HAND ELEVATING BEVEL GEAR AND PINION

1-C.I. P-5 / 193 1-M.S.

Fig. 2

Machinery N.Y.



Data for Spiral Gears	L.H.
No. of Teeth	28
Pitch Diameter	3.5
Outside Diameter	3.6767
Circular Pitch	.3927
Angle of Teeth with Axis	45
Normal Circular Pitch	.2776
Pitch of Cutter	11.313
Addendum	.0883
Thickness of Tooth	.139
Whole Depth	.190
No of Cutter	1
Exact Lead of Spiral	10.995
Approximate Lead of Spiral	10.997
Gears to Cut Spiral	
Gear on Worm	45
1st Gear on Stud	26
2nd Gear on Stud	61
Gear on Screw	96

SPIRAL GEARS

DRIVEN 1-C.I. A-B-3 / 8 FINISH

DRIVING 1-C.I. A-B-3 / 7 FINISH

Fig. 4

Examples of Methods of Dimensioning, taken from Brown & Sharpe Gear Drawings.

tional resistances. Therefore instead of (9) we should have,

$$E_{\text{total}} = e\,E + e'\,E_a + e''\,E_r$$

where e, e', e'' represent the per cent of efficiency of the mechanism between the moving parts giving rise to E, E_a and E_r respectively, and the brake.

Thus in Fig. 2, where we have a gear train introduced between the brake and the load drum, we would have for the several kinetic energies to be absorbed by the brake the following:

1.—eE for the load W, in which E is from (5) and e is the efficiency of the entire mechanism, including ropes, shaft b in its bearings, gears c, and shaft a in its bearings.

2.—$e'E_r$ for the rotating parts, drum and gear, on shaft b, in which E_r is from (7), and e' is the efficiency of shaft b

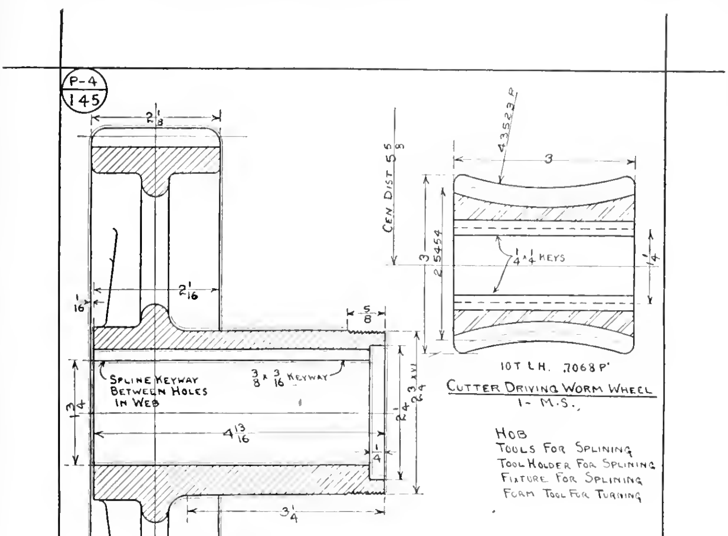
in its bearings, the gears c, and the shaft a in its bearings.

3.—$e''E_r$ for the rotating parts, armature, brake drum, and pinion on shaft a, in which E'_r is from (7) and e'' is the efficiency of the shaft a in its bearings.

4.—E_a from (6).

In one of the data sheets for March, 1903, was a convenient chart for the solution of the holding power and tensions in the band brake. This chart applied to flat-faced brake wheels only, and since the V-grooved brake wheel is often met with, we must find the increased holding power due to the wedging of the blocks into the V-groove. Formulas for the latter type of brake wheel were derived in an article by the writer in MACHINERY for March, 1905, as follows:

Let N = normal pressure on a flat-faced wheel.



	WORM
NUMBER OF TEETH	46 L.H
PITCH DIAM.	900
OUTSIDE DIAM	9.295
CIRCULAR PITCH	.6146
ANGLE OF TEETH WITH AXIS	41°-0'
NORMAL CIRCULAR PITCH,	.4638
PITCH OF CUTTER	67736
ADDENDUM	.1477
THICKNESS OF TOOTH	.2319
WHOLE DEPTH OF TOOTH	.3186
NO CUTTER	SPECIAL
EXACT LEAD OF SPIRAL	32 5157
APPROXIMATE LEAD OF SPIRAL	32 5157
GEARS ON MILL MCH TO CUT SPIRAL	
GEAR ON WORM	88
1ST GEAR ON STUD	24
2ND GEAR ON STUD	47
GEAR ON SCREW	53

TIME	P-4	LOT
NO 4 AUTO. GEAR CUTT. MACH.		
CUTTER SPIN. WORM & WHEEL		
SEPT 27, 1902		
BROWN & SHARPE MFG CO. PROVIDENCE, R.I.	P-4 145	

3-10-06 9-28-05 9-2-05 9-5-04 9-22-03

P4

Fig. 6. The Worm Drive of the Brown & Sharpe Gear Cutter.

n = normal pressure on one side of a V-grooved wheel.

$2n$ = total normal pressure on a V-grooved wheel.

P = tangential force for a flat-faced wheel.

P_1 = tangential force for a V-grooved wheel.

a = half the included angle of the groove.

Then

$$2n = \frac{N}{\sin a}$$

$$P_1 = P \operatorname{cosec} a.$$

In the article referred to above are illustrations of several types of band brakes, with a calculation worked out for the holding power, to which the reader interested in the subject is referred.

THE FIGURING OF GEAR DRAWINGS.

L. D. BURLINGAME.

We have found constant trouble both in our own drafting department and in the case of drawings sent to us from customers, in the methods, or lack of methods, employed in figuring gear drawings. This has led to the establishment of a standard method of figuring, which meets the requirements of our shop and which has been modified from time to time to give the required information in the best possible form. At the suggestion of the editor, I am sending a number of samples showing the method employed by us, and these drawings also illustrate a number of other points of our established drafting room practice.

In the simplest case, that of the spur gear, the number of teeth and the pitch, with the outside diameter, give the important data as far as the cutting of the teeth is concerned. Where a special cutter is used it is numbered and called for on the drawing, so that the cutter can be quickly selected when the gear is to be cut, thus avoiding the possibility of a mistake. It will also be noticed that the corners of the teeth are rounded; this is to give a neater appearance to the gear and make it better in handling, a point that applies especially to change gears. It will be noticed that no inch marks are used on this drawing as all of our figures are in inches.

Fig. 2 illustrates an ordinary case of a pair of bevel gears. We choose to give the angles and the outside diameter in tabular form to avoid confusion on the drawing. It will be noticed in this and other cases that stock is allowed for fitting where required and this is indicated on the drawing. The object of making all the blanks alike in the dimension specified is to avoid resetting in the gear-cutting machine when carrying through a lot of gears. No. 3 gives further particulars as to the plan on which bevel gears are figured and some of the reasons for same. This drawing is in the reference book at every man's desk, and gives him the instructions required for figuring, so that all of our work may be uniform.

Fig. 4 shows a pair of spiral gears. The data here is arranged and tabulated as specified in Brown & Sharpe's "Formulas in Gearing," which contain formulas for all of these calculations and a copy of which is also at every draftsman's table. Our practice in figuring keys is indicated here, the key being shown in position in the piece where it is tight. If the key were tight in the shaft, the keyway only would be shown in the drawing of the gear.

Fig. 5 shows the worm and worm wheel. This indicates our method of showing finish, the finish lines being indicated by a red line against the surfaces that are machined. This shows on the blueprint as a fainter line and has been used by us for many years in preference to the "f" or other symbol ordinarily used. This is some additional expense, as we re-line these with prepared red on the blueprint, but we consider it justified for our work. It will be noticed that the distance between centers of the worm and wheel is figured. It will also be noted that the end of the worm is turned down to a diameter corresponding to the bottom diameter of the thread, this serving as a guide for depth in threading the worm.

Fig. 6 illustrates a worm and wheel in which the worm is much larger than the worm wheel, an unusual condition. In this case the worm is cut with a cutter more in the manner of a spiral gear, while the worm wheel is hobbed. This sheet will illustrate our method of titling our drawings. The figures showing faintly at the lower left-hand corner indicate the

dates that blueprints have been made from this sheet. The numbers in the circles in the corners give, above, the symbol number of the machine, with the consecutive sheet number below.

Besides these gears shown, there are coming up in our regular work cases of intermittent gears, internal gears, racks and pinions, and special data required for planed bevel gears, all of which have to be figured in a systematic manner.

[Perhaps it might be well to call attention to a few additional points suggested by the drawings Mr. Burlingame has sent us. In Fig. 1, which shows a quill gear for a milling machine, it will be noted that under the gear is marked the symbol "69 T. 7 P.," while under the pinion is marked "24 T. 6 P." This means, of course, that there are 69 and 24 teeth, respectively, in these gears, and that they are cut with a 7-pitch and a 6-pitch cutter. Although it is aside from the question under discussion, it is interesting to note the fact that the center of the body of the quill gear is represented as being knurled with a "No. 5" knurl. Standard pitches for knurling have been adopted by this firm, samples of which are on exhibition in the drafting room, where they can be referred to as often as necessary. In the bevel gear drawings, Figs. 2 and 3, it will be noted that the edge and face angles are measured from a line perpendicular to the axis of the gear. This is the most convenient way of dimensioning it for the workman, whether the face and edge are finished with a square-nose tool or turned with the compound rest. In the one case the faceplate surface is the plane of reference, and a protractor may be directly applied to it for setting the tool. If the gear, on the other hand, is so large that the face has to be turned, the graduations on the compound rests of most lathes are such as to give readings corresponding to this method of dimensioning.

In the table giving the dimensions for spiral gears but one column is given, since the two gears are evidently identical so far as the teeth themselves are concerned. The letters "L. H.," given in the same line with the number of teeth refer, of course, to the fact that they are cut with a left-hand spiral. In the drawing of the worm, ".200 L" means, of course, 0.200 inch lead, while "200′ P" means 0.200 inch circumferential pitch. The distinction made between these two terms lead and pitch would be evident in the case of a double-threaded worm; for instance, if the pitch of such a worm were 0.200 inch the lead would be 0.400 inch, the lead being the linear distance that a tooth advances for every revolution of the worm. The drawing reproduced in Fig. 6 is interesting in that it gives data for one size of the well-known and somewhat peculiar cutter spindle driving gear used on the Brown & Sharpe automatic gear-cutting machine, and is so reproduced as to give some idea of the general drafting room practice of the Brown & Sharpe Mfg. Co. The worm wheel is the driver in this case. In the table, the "exact lead" is that required by the mathematical solution of the problems. The "approximate lead" is that given by the gears listed, which in this case figure out exactly right.

These drawings as a whole are quite suggestive as showing the practice of a firm which cuts a great deal of gearing for outside parties as well as for its own use, and which thus has an opportunity to judge as to the most convenient way of arranging and dimensioning drawings of gears. The point brought out in Figs. 2 and 3, in relation to making the distance from the outside edge of the teeth to the rear end of the hub a constant quantity in all the blanks of a given lot, is an important one and attention to it will save considerable time in the re-setting of the machine when cutting the gears.—EDITOR.]

* * *

THE IMPORTANCE OF CRYSTALLOGRAPHY IN THE STUDY OF MATERIALS OF CONSTRUCTION.

The bearing of crystallography on engineering, says Dr. Fulton in the *Times Engineering Supplement*, is of no trifling character, since the whole of the metallic materials employed by the engineer are crystalline substances. Hundreds of valuable lives have been sacrificed by the existence of flaws in metallic beams, girders, tie-rods, bolts, rails, wheels, and axles, consequent on local development of crystalline structure or on the local separation of crystals of a particular constituent in an alloy or a steel. Many of these might have been saved if we had possessed exact knowledge of the crystallographical character of metals, and of the influence upon it of the various metallurgical and mechanical processes to which steels are subject. The fundamental fact of the science is, that every solid chemical element, whether metallic or non-metallic, and every solid substance of definite chemical composition, be it naturally occurring or artificially prepared (with the exception of the few which have never yet been obtained in the crystalline condition owing to the great viscosity of their solutions or of their molecules when in the state of fusion), has its own definite crystalline form, which is just as much a characteristic feature of the substance, by which it can be identified, as is any one of its chemical or physical properties. This is a statement which it has only quite recently been possible to make with certainty. For it was for a long time thought that the members of the numerous well-known series of analogous chemical compounds (which only differ in containing a different member of a family group of chemical elements as their dominating and generally metallic constituent), were absolutely identical in their crystalline form, and they were consequently classed as "isomorphous." But Prof. P. von Groth, of Munich, has been able to prove, as the result of fifteen years' work, that although the forms are very similar, and although they belong to the same type of symmetry, the angles between their corresponding faces are different, to the extent it may be of only a few minutes of arc, but in some cases by as much as a couple of degrees. Moreover, the amount of the difference is governed by a definite law, which connects the atomic weight of the metal or other dominating (acid-forming) element present with the whole of the properties of the crystals, whether of exterior form, of optical character, or of internal structure. The statement becomes all the more interesting when it is pointed out that the number of types of symmetry, according to which crystals can be formed, is only thirty-two, while the number of crystalline substances is legion. For in spite of this fact it is true that the crystals of no two different substances are precisely alike, either in their exterior form or with regard to their internal properties. They may approximate closely in external shape (although more dissimilar in internal properties) if they are chemically analogous, or they may be very different indeed in all their properties if they are chemically unlike.

* * *

George S. Rice, chief engineer of the Board of Rapid Transit Commissioners, has submitted a report upon ventilating the New York Subway. The present difficulties arise because the heat generated in the operation of trains is not dissipated in a sufficiently rapid manner. To improve the conditions in summer the air must be renewed more frequently, and it must also be cooled. Several Sturtevant fans were installed last summer and served for experimental purposes. No definite plan is recommended for cooling, although Mr. Rice suggests three ways in which it may be accomplished, *viz.*, by evaporation of water, by refrigeration, and by absorbing the heat by disposing relatively cool water throughout the subway in some manner to be determined upon. To renew the air, Mr. Rice recommends the use of exhaust fans and also of automatic ventilators, so constructed that they will only open outward, and the covers balanced so that they will remain closed, except when the interior air pressure is greater than that outside. When a train approaches a ventilator, the air pressure in its vicinity will be increased and there will be an outrush of warm air. Six fan outfits are recommended at a cost of $40,000 for the portion between Columbus Circle and Ninety-sixth Street, where the Subway is much cooler than in the southern end of the system. This apparatus would have the capacity for renewing the air in the Subway once every thirty minutes.

* * *

A novel arrangement is in use by the Philadelphia Rapid Transit Co., Philadelphia, Pa., for the local welding of track joints. This consists of a small foundry cupola carried on a trolley car and supplied with blast from an electric pressure blower.

SPRING SCREW THREADING DIES.

ERIK OBERG.

Erik Oberg.

It is undoubtedly true—whatever the cause may be—that there is, as a rule, a great deal more said in the trade papers about taps than there is about threading dies. The reason for this cannot be that taps are considered any more important to the average shop than are threading dies, but rather that dies are carefully avoided by contributors, because of being so much more difficult to make. It is far more generally known what is necessary to make a good cutting tap than what are the essential points in making a good cutting die. However, the die is used for external thread-cutting just as often as the tap is used to thread the corresponding nut, and for this reason threading dies ought to be given a place equally prominent with taps in the manufacture of shop tools.

At present no threading dies are used to such a great extent as are spring screw threading dies. The increasing importance of automatic screw machines has been the one great factor which has added most to the demand for this class of dies. There is, however, still a great deal to wish for in regard to the manufacture of these dies, and there are a number of suggestions which the writer would call to the attention of those who are interested in the gradual perfection of so universally used a shop tool.

There are in general three main requirements for a threading die. The cut should be nice and clean, the thread should be of a perfect form, and the threaded piece should be of the exact diameter required. In order to obtain this there are several points to be taken into consideration.

In the first place it must be observed that a die with a thread cut perfectly straight or parallel would act exactly the same as a tap without back taper, that is, a tap having the same angle diameter at the shank end as at the point. This question in relation to taps was mentioned in an article in MACHINERY, October, 1905, in connection with the relief of taps. The trouble encountered in using taps made without back taper will also appear in dies made in the same manner. To overcome the difficulties arising, and in order to give to the die a certain amount of back taper, usually called clearance, dies for the market are generally made a certain amount over the size required, and then the size to be cut is obtained by means of an adjusting collar, forcing the prongs of the die down sufficiently to produce the correct diameter required on the piece to be threaded. This will, of course, give the die a certain back taper, the amount of which will depend upon the amount over the actual size the die was originally made. The collar being applied at the front end of the die, it will evidently spring the prongs more at the point, where it is applied, than further up, nearer the solid part of the die. This is the general procedure of making spring screw dies for the market, and we will now analyze the results, and see whether this die fills our three main requirements mentioned above.

The die has ample clearance and will almost invariably produce a smooth, cleancut thread. The size of the thread on the threaded piece can also be exactly correct, as the adjusting collar, usually called clamp collar, can be so adjusted as to give any size wished for within certain limits. The form of the thread, however, will not be perfect, as can readily be seen from the cut, Fig. 1, where the case is shown exaggerated. By bending the prongs inward the thread will evidently not move inward at right angles to the axis of the die, but will move along an arc, thus causing the thread to be of incorrect angle in the piece cut, one side of the thread making an angle of more, and one an angle of less than 30 degrees with the axis.

In order to eliminate this error, and still maintain the necessary back taper or clearance, the correct size should originally be at the front end of the die, and the diameter of the thread in the die should gradually increase backward, that is, the die should be made with back taper from the beginning. On large sizes this is, of course, very easily accomplished by setting the taper bar of the machine where the die is chased out over an amount equal to the amount of back taper desired. On small sizes, however, this is impractical, and on very small sizes absolutely impossible. Therefore, in order to obtain a die made in a way that will produce results required, the die must be tapped out from the back end with a tap having been cut with the taper required in the die.

The amount of the clearance mentioned should vary according to the kind of metal the die is to be used upon, the clearance being greater for brass than for steel. Opinions vary as to what is the best amount of back taper to give to a die. While some consider that a clearance of 0.003 inch per inch is ample for cutting steel or iron, and 0.005 inch per inch for brass, others claim that one might give even as much as 0.010 inch per inch clearance for steel and iron, and 0.015 inch per inch for dies cutting brass, copper and metals of similar structure. It may be safe to say that any figure between the extreme limits given above will prove satisfactory, and that the exact amount of clearance is comparatively unimportant.

A die made according to the latter method described would, when new, cut a perfectly correct thread. Suppose now that the die should wear, and in order to obtain the correct size of the thread the adjusting collar had to be tightened. In such a case a slight error in the form of the thread would occur, on the grounds mentioned previously, but considering the way in which this die is made, the error is reduced to a minimum. In fact, it is easily seen, that the maximum error, when a die of this kind is almost worn out, cannot be any greater than the minimum error occurring in a new die with the same length of thread cut straight, and made a sufficient amount oversize to produce the same amount of back taper by forcing the prongs in at the point.

The reason for continuing to manufacture spring screw dies in the old manner, when the superiority of dies made according to the system outlined is well known by manufacturers, is

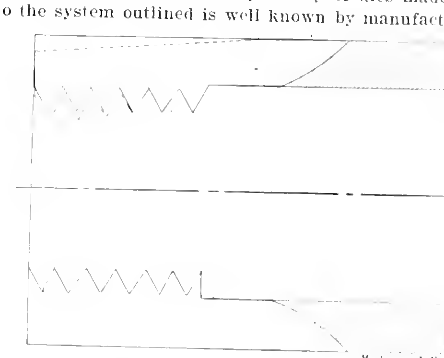


Fig. 1. The Faulty Action of Spring Dies of Usual Design when Adjusted for Smaller Diameters.

one merely of expense. It would make the die more expensive to grind on the outside, true with the thread, as a taper arbor would be more difficult to make than a straight arbor, but it is unquestionable that the increase in expense is very slight if compared with the superior qualities of the die. The grinding of the outside of the die should never be overlooked by those desiring a good die, especially if a solid holder is used. It must, however, be admitted that most dies made for the market are not ground on the outside, a fact of which most users probably are painfully aware, as it takes a great deal of experimenting and attention to produce desirable results with dies where the thread is not true with the outside. It also seems ridiculous to spend so much time and care in producing a good thread in the die, and then to overlook a factor equally important to accomplish perfect results.

Another point of utmost importance to make spring screw dies cut correctly is the way in which the prongs or lands of

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the die are being adjusted to cut the proper size. The clamp collars generally used for this are nothing but split steel rings. The adjustment is secured by means of a screw, and it is readily seen from the cut, Fig. 2, that the action of the steel collar on the prongs of the die is not uniform, that is, it will not give an equal pressure to the various prongs. The result of this will be a die with its thread out of round, and all the care and precautions taken in making a perfect die have become useless by the use of improper means for adjusting

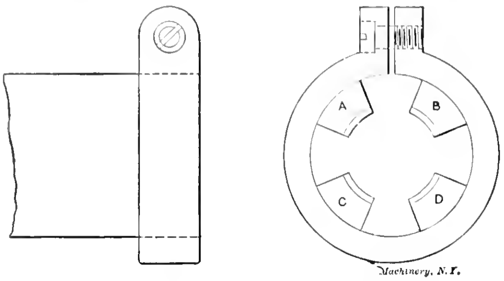


Fig. 2. The usual Split Ring Adjustment.

the prongs. Being out of true the die cannot have all the prongs cutting, which of course is essential in producing good results.

The only correct principle to apply for adjusting the prongs is a solid ring which will evenly force all the prongs equally toward the center. This can be accomplished by making a solid steel ring with the hole tapered, and tapering the fluted end of the die to suit the taper in the ring. (See Fig. 3.) The amount of taper in the ring and on the prongs will be directly dependent upon the adjustment wanted in the die.

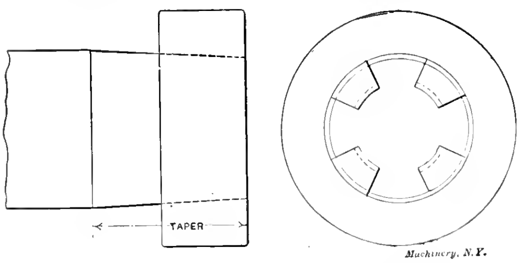


Fig. 3. The More Efficient Taper Collar Adjustment.

Spring screw dies are generally made with four flutes, but experience has taught that a die of this kind will almost invariably have only two lands cutting. A die with three flutes, however, will, even if slightly out of true on account of spring in the hardening, have the three lands cut evenly, and three flutes are therefore to be recommended. There is also another advantage gained by giving a die only three flutes. The lands become wide and stiff, while the chip-room may still be equally large or even larger. It may be said as an objection to wide lands that they will necessarily produce more friction between the die and the piece to be cut. This can easily be overcome by milling the prongs as shown in Fig. 4.

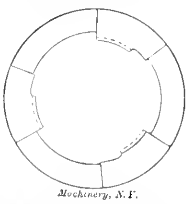


Fig. 4. Relief of Lands to Decrease Friction.

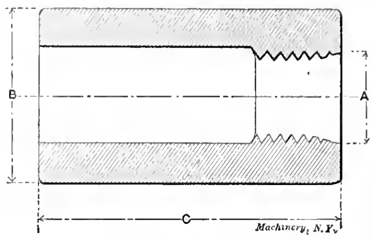
When fluting, the kind of material upon which the die is to be used, should also be considered. If the die is to be used on soft metals, such as brass, the cutting face of the prongs is usually made to come a small amount ahead of the center, while on dies used for steel or iron the cutting face is radial.

To prevent the die from springing out of shape in hardening it is advisable not to flute right through the metal into the hole, but to leave a small amount to be removed when grinding the flutes after the die has been hardened and finish ground on the outside.

The only point now remaining to be considered is that of the chamfer, which is, of course, greatly dependent upon the class of work to be done. It is evident that the longer chamfer, or taper on the top of the threads, one can allow in a die, the better results will be obtained, as it is obvious that a greater number of teeth will then do the cutting, and each tooth will have less to remove. The result will be a smoother thread.

Below will be found tables giving proper proportions of outside diameter and length of spring screw dies to cut certain sizes, and also proper length of thread necessary for certain pitches.

TABLE GIVING PROPORTIONS OF SPRING SCREW DIES.



Diameter of Cut.	Outside Diameter.	Length.	Diameter of Cut.	Outside Diameter.	Length.
A	B	C	A	B	C
$\frac{1}{8}$	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$	$2\frac{1}{2}$
$\frac{3}{16}$	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{3}{4}$	2	3
$\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{7}{8}$	2	3
$\frac{1}{4}$	$\frac{3}{4}$	$1\frac{3}{4}$	1	2	3
$\frac{5}{16}$	$\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{8}$	2	3
$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{4}$	2	3
$\frac{3}{8}$	1	2	$1\frac{1}{8}$	$2\frac{1}{2}$	$3\frac{1}{2}$
$\frac{7}{16}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	$3\frac{1}{2}$
$\frac{1}{2}$	1	2	$1\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$
$\frac{1}{2}$	$1\frac{3}{8}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{1}{4}$	4
$\frac{9}{16}$	$1\frac{3}{8}$	$2\frac{1}{2}$	2	$3\frac{1}{4}$	4
$\frac{5}{8}$	$1\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$3\frac{1}{4}$	4

TABLE GIVING THE LENGTH OF THREAD FOR VARIOUS PITCHES.

No. of Threads per inch.	Length of Thread.	No. of Threads per inch.	Length of Thread.	No. of Threads per inch.	Length of Thread.
40	$\frac{3}{16}$	16	$\frac{7}{16}$	8	$\frac{7}{8}$
36	$\frac{7}{32}$	14	$\frac{1}{2}$	7	1
32	$\frac{1}{4}$	13	$\frac{9}{16}$	6	$1\frac{3}{16}$
28	$\frac{9}{32}$	12	$\frac{5}{8}$	$5\frac{1}{2}$	$1\frac{5}{16}$
24	$\frac{5}{16}$	11	$\frac{11}{16}$	5	$1\frac{7}{16}$
20	$\frac{3}{8}$	10	$\frac{3}{4}$	$4\frac{1}{2}$	$1\frac{9}{16}$
18	$\frac{13}{32}$	9	$\frac{13}{16}$	..	...

* * *

The exigencies to which ocean freight is subjected require that goods for foreign shipment be packed much more substantially than for domestic shipment. This is obvious but unfortunately many American manufacturers appear not to understand it, or if they do understand it, they ignore it. The consequence is that American goods are commonly received by foreign consignees in very bad shape. The *Far Eastern Review* shows a number of halftones of shipments received at the Manila custom house in frightful disorder. One example is that of a hundred cases of watch chains whose contents are distributed about in a most promiscuous fashion. Examples of textile goods are shown in bad condition. In many cases the goods are so badly damaged that they cannot be sold at anywhere near full value. An example of a machine that was destroyed in shipment was a piano-player which had been well packed with the exception that the internal mechanism of the player itself was not well supported relative to its case. The consequence was that when it was inverted the supports were not strong enough to support the action and it was wrecked. So in packing machinery it should be remembered that first of all the case must be strong and well braced; second, that the machine should be securely blocked in the case so that it cannot shift relative to it, and third, that the parts of the machine itself shall be well supported by wooden blocks or other means so that if placed in a side or inverted position no destructive strain shall be brought upon parts unable to bear them.

FLOORPLATE WORK IN THE ALLIS-CHALMERS SHOPS.

The idea of carrying the tools to the work rather than of transporting the work to the tools is one of gradual growth in machine shop work, and we are unable to say when the first floorplate originated. But one thing is sure, and that is, the floorplate where special machine tools, driven by portable motors, are used to perform all the machining operations required on large castings, is one of comparatively recent development, being coincident with the growth of the electrical industry. In fact we may safely say the electrical industry is largely responsible; it made possible the concentration of power in larger units, undoubtedly, than would have been feasible by any means of lineshaft transmission, and the building of these large units made new machine shop methods imperative.

The Allis-Chalmers Co. at West Allis, Wis., in common with the other builders of large electrical and steam units has an extensive floor-plate system in their heavy machine shop No. 1. It has some features of novelty inasmuch as some of the tools are not strictly of a portable nature but are set with reference to the floorplate so as to allow of advantageous use

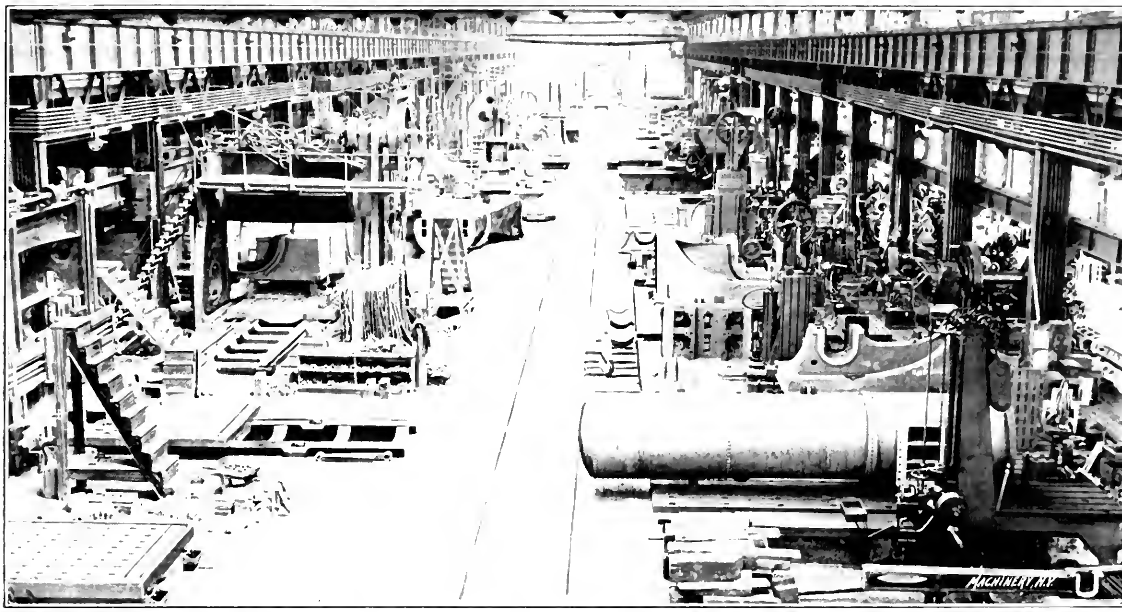


Fig. 1. General View of Heavy Machine Shop, at the West Allis Works

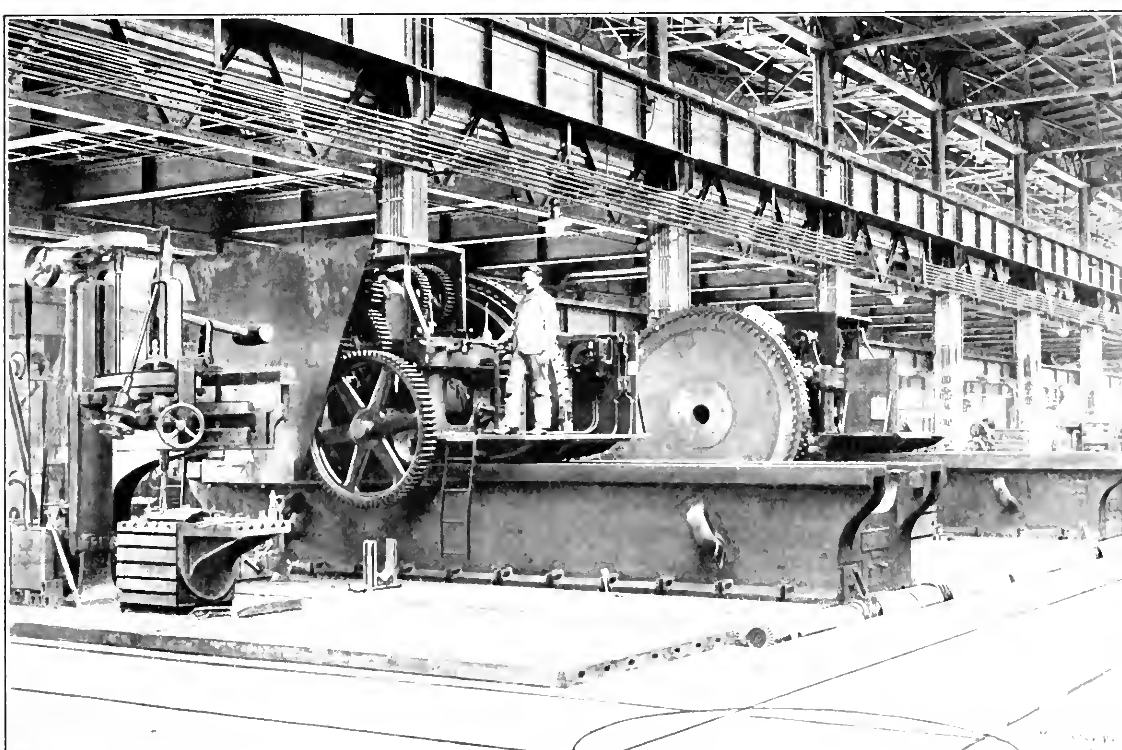


Fig. 2. Double Rotary Planer for Facing Housings and Cylinders

with it and, in fact, so as to practically form a part of it. Fig. 1 shows a general view of this shop with the floorplate on the right. It is laid down in the central bay where it can be served by the large traveling crane, and it might be said here

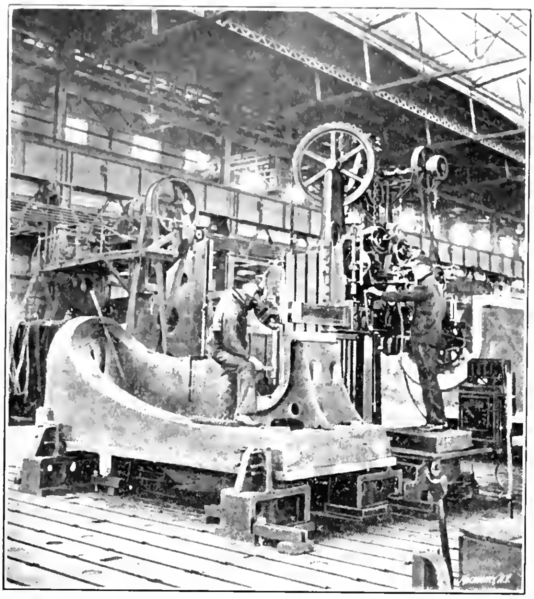


Fig. 3. Morton Shaper Finishing Main Bearing Seat.

that it is to the traveling crane that the floorplate largely owes its value.

The tool equipment of the floorplate of course required machines that can bore, drill, slot, face, mill and plane. Fig. 2 shows a pair of Bement-Niles rotary planers having cutter

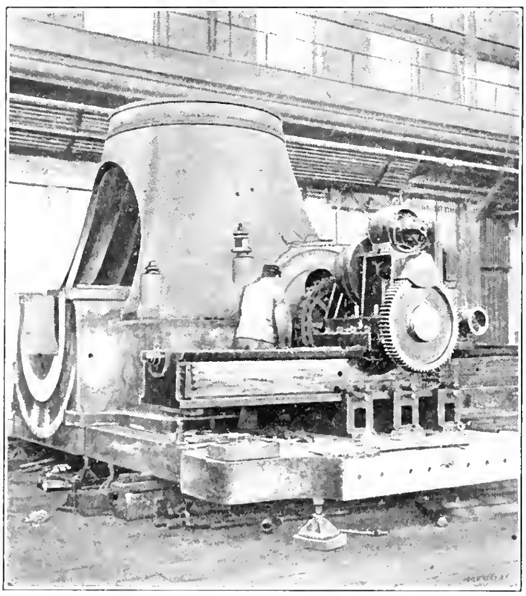


Fig. 4. Rotary Planer on Supplementary Bed Plate.

heads 120 inches diameter. These planers are set parallel so that they may operate on both ends of a casting at once, the heads traveling while the casting remains stationary on the floorplate. The distance between the two machines is adjustable, the large covered screw in the front showing one of the pair employed for shifting them. These planers are mostly used for facing housings and cylinders of large Corliss engines.

The planing operations are largely done on this floorplate with Morton draw-cut shapers. Fig. 3 shows one of these machines at work on the main bearing of a horizontal engine frame. The frame is fixed in blocks which support and clamp it in position and the machine is mounted alongside the floorplate, being driven, of course, by an electric motor as are all the others.

Fig. 5 shows another view of the Morton draw-cut shaper arranged for boring. This machine was designed for both planing and boring. In this case the boring head is mounted on the end of the planing ram, or rather on the end of the boring bar mounted in the ram. The head of the machine is counterbalanced by the pneumatic cylinder shown at the left of the column which avoids the heavy counterbalance otherwise necessary.

Fig. 4 shows a Newton machine tool of the rotary planer type; it happens to be used in this case on the housing of a vertical engine, using the bedplate as its support instead of

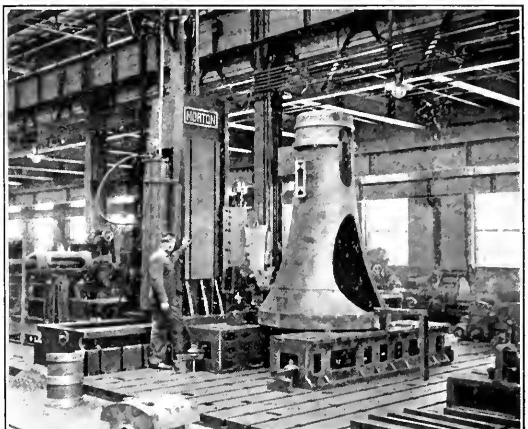


Fig. 5. Draw Cut Shaper arranged for Boring.

the regular floorplate. The motor is mounted on the traversing head, the same as with the machine shown in Fig. 2, the four-wire system connections showing on the side of the bed.

Fig. 6 shows perhaps the most interesting machine of the lot, being a special tool designed by the engineering department of the Allis-Chalmers Co. and built by the Niles-Bement-Pond Co. It is a boring and drilling machine, its work being the facing and boring of engine frames, and drilling the bolt holes for the cylinders, without the use of jigs. This machine is permanently erected upon a foundation adjoining the floorplate and is accurately lined up with the planed grooves

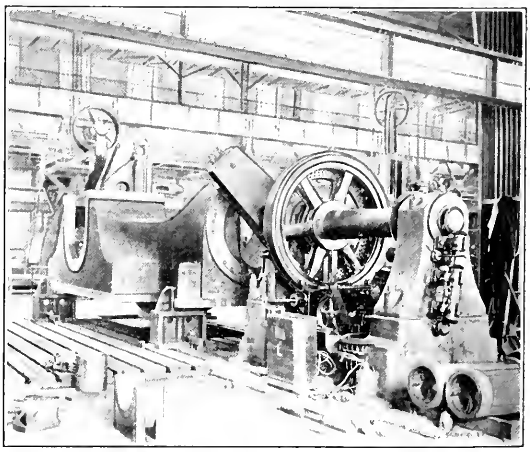


Fig. 6. Machine for Facing, Boring and Drilling Cylinder Ends, Etc.

in it. These grooves are also used, of course, for lining the engine bed which is to be machined. The indexing plate, with concentric circles of holes for indexing the drill arm when drilling bolt holes, is plainly shown in the cut. The tool carrier which is in position for facing the end has automatic feed for both transverse and longitudinal cuts.

THE APPRENTICESHIP QUESTION.

"ENTROPY."

Apprentices, their welfare, and the good of the shops hiring them, have held uppermost place in my thoughts for some time past. When I hear of anyone doing what Mr. Alexander is doing at Lynn I get to hoping that Prof. Sweet or some one like him will get a school going which shall be open to all comers. What Mr. Alexander is doing is a great step toward proving what I have always contended, namely, that apprentices, properly handled, are a paying proposition. But a little shop with 40 or 50 men and 5 or 6 apprentices of various stages of development simply cannot do what they are doing at Lynn. So far it seems to be impossible to find men with sufficient faith in apprentice education to back it either from a philanthropic or a business standpoint. But suppose we try co-operation. In my town there are quite a number of small shops that have about 30 apprentices among them. There is room for a lot more but this number they have. These boys are each learning to do some part of the work of the particular shop in which they are employed and do it in a way that their particular boss thinks is right. But the boy in the machine tool shop never sees a shrink fit made and the boy over where they are building rolling mill machinery never saw any scraping done, unless it were a babbitted box that didn't set down good. Most of these boys will be wise enough, if they are like their predecessors, to go away to some other shop when their time is out. They will be totally at sea at first both as to the work and the ways of the shop and the peculiarities of the new foreman. And they are not qualified as journeymen till they have beaten around a while. Now suppose these shops should swap apprentices occasionally so that in three years time they would have seen the inside of most of the shops and run up against several foremen, and they would be worth more to themselves and to their employers than they are now.

Then let the boys off a few hours a week, say the last two hours every day, and get some good shop man (no school teachers need apply) to give them lessons in arithmetic, natural science (physics they call it now but we used to take it sugar coated) just a little algebra and trigonometry, a whole lot of geometry and more drawing. A machinist can stand quite a lot of these things and not get so swelled a head but that he can keep his overalls on. If the man that teaches these things could go around from one shop to another all the week and see that the boys got a show at some decent work and that they knew the why of what they did, then they might be worth enough more so that the shops could afford to pay the teacher a fair salary. But then suppose these 30 boys had their pay cut down from an average of $300 per year, as it is now, to $200. They will stand it if they can see that they are getting something for their money. The best way would be to pay them just the same as now but to charge them a hundred dollars a year for the teaching done and for pushing them along faster. Take off the time limit and say to the boy, we will pay you what you earn regardless of whether it is 50 cents or $3 a day whenever you do earn it. Almost any boy with this incentive and the aid of the instructor can cut enough off his three years to more than pay this $100 per year. More than that even with only 30 apprentices less than $100 per year per boy will pay for the instructor, and one instructor ought to handle 60 boys easily, which would cut it still more.

But there is one thing still more vital to the interests of the machinery builder and that is the social position of his workmen. Just so long as a machinist is rightfully known as a "greasy mechanic" boys will prefer counter-jumping at $10 a week to running a lathe at $15. The ladies are at the bottom of it. Who wants to go to call on his best girl and find her sitting in the hammock with a bank clerk and know the reason is because the other fellow's hands are not grimy? I have known case after case where boys who have started into the machine business have left it to go at something clean because of wife or sweetheart. Now I have worked over the lathe and planer and gotten down into the dirt enough so that no one will accuse me of being a kid-glove mechanic if I have my say. I believe that a man can do a good day's work in a shop and keep clean. He cannot do it without more care on the part of the management than usually obtains and he won't do it unless he is compelled to by the management. Just why I don't know, but it is characteristic of a machinist that while in the shop he delights to wallow in dirt and when he is out he is equally delighted to kick about it. One thing that would help, unless I am greatly mistaken, would be to change his hours of travel so that he would not have to travel to and from work with the company of Poles and Dagoes that he rubs elbows with now. How can he hold up his head if he has to travel with that crowd? The next time when things are flush and you feel a desire coming over you to raise the pay of your help, cut off some time from the day's work instead of adding to their pay. Let them come down to work a little later than the Dagoes and go home a little earlier. Get them out in the collar and cuff and necktie brigade, and make them keep clean in the shop. They can if they will and you will, and it will pay you well and them too.

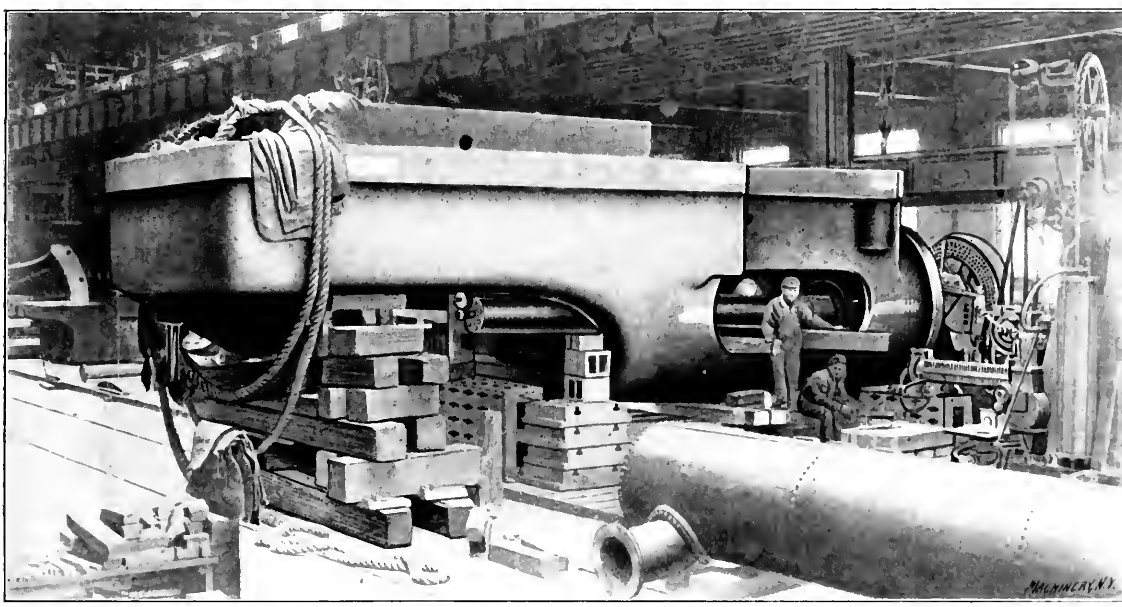


Fig 7. Facing, Boring and Drilling Machine, shown also in Fig. 6, Finishing the Cylinder End of a massive Rolling Mill Engine Frame. The Casting weighed 105 Tons.

PUNCH AND DIE WORK.—2.

E. R. MARKHAM.

Sectional Dies.

Dies are many times made in two or more sections in order to facilitate the operation of working the opening to shape. In other cases the die, if solid, would be so large as to render it well-nigh impossible to harden it in a shop with only the usual facilities for doing work of this class. And then again if it should go out of shape in hardening, it would be a difficult task to remedy the defect. If made in sections, as shown in Fig. 25, it would be possible to pene or grind to original shape with little trouble.

A die of the design shown in Fig. 26 may be made sectional because it is much easier and cheaper to make than if solid. The halves are held in their proper location by dowel pins. They are held together by the shoe which secures them in the press. If the die is comparatively small, the circular shapes at each end and center are produced by first drilling and then reaming from the back, with a reamer of the proper angle. The sections may be separated and the

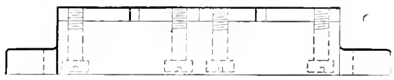


Fig. 25. Sectional Die held by Screws.

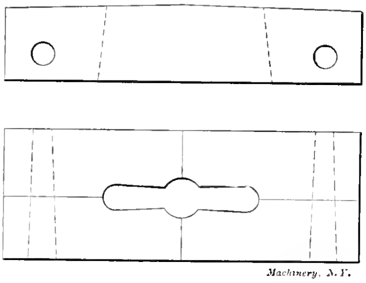


Fig. 26. Sectional Die Located by Taper Pins.

balance of the stock removed in shaper, planer or milling machine. When this stock is removed the die may be held at the proper angle to produce the desired clearance. After machining as close as possible the surfaces may be finished by means of the file and scraper.

When the opening has been finished to the templet, the top may be given the proper *shear*. In order to facilitate the operation of grinding when the die is dull, the stock may be removed, as in Fig. 27, leaving about ¼-inch each side of the opening at the narrowest portion. There are certain forms of dies where it is not feasible to cut away a portion of the top, as shown, but where it can be done it saves much time when grinding.

Should the workman, through misunderstanding or carelessness, make the opening too large at any point, he should not attempt to pene the stock in cold, as is sometimes done, for while it is possible to do this and then finish the surfaces

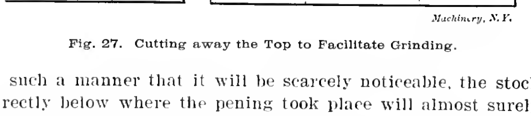


Fig. 27. Cutting away the Top to Facilitate Grinding.

in such a manner that it will be scarcely noticeable, the stock directly below where the pening took place will almost surely crack away during the life of the die.

Should the mistake referred to occur, heat the die to a forging heat when the stock may be set in without injury to the steel. When setting in, a blacksmith's fulling tool may be used, this placed on the face of the die and struck with a sledge, as in Fig. 28. If there is objection to disfiguring the top surface of the die of course this method cannot be used, but if the top is to be cut away, as shown in Fig. 27, the depression made by the fulling tool would be entirely cut away. It is never good practice to bend, set in or otherwise alter the form of a steel when cold if it is to be hardened, as such attempts nearly always end in a manner entirely unsatisfactory.

When dies become worn so the opening is too large or the top edge of the walls of opening are worn so the die is "bell muzzled" it may be heated to a forging heat, set in with a fulling tool, or a punch of the desired shape, after which it may be reheated to a low red and annealed. After annealing it may be reworked to size. The writer has reworked dies

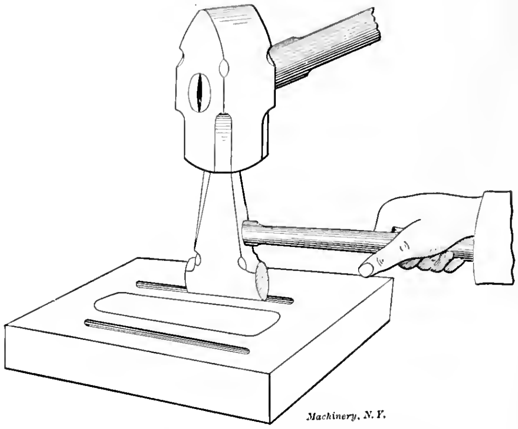


Fig. 28. Closing up a Die which has Worn Large.

several times in the manner described with excellent results, thus effecting a considerable saving, as otherwise it would have been necessary to make new dies, and the die could be reworked at a fraction of the expense of a new one.

When making a sectional die, it is possible in case the opening is a trifle too large, to work a little stock off the faces that come together, provided the outer edges have not been planed to fit the holder; also, if it is allowable, these surfaces may be cut away the desired amount and a strip of stock of the proper thickness placed between the die and holder. Considering the liability of a mistake taking place when the beginner is doing work of this kind, it is, generally speaking, advisable to leave the fitting of the die to the holder until the opening has been worked to size.

Hardening Dies.

There is probably no one article the hardener is called on to "tackle" that he dreads any more than a die. The more complex its nature the more he dreads it, and if he is at all nervous he will worry over it until he worries himself into a condition that makes it well nigh impossible to successfully do the job. If he succeeds in bringing it out of the bath without a crack, he gives the credit to "luck"; and if the expected happens it is no more than he was looking for. This is unfortunate, as there is no need of losing dies in the operation of hardening. Of course, if a piece of imperfect steel is used, it is almost sure to go to pieces in the bath; but if the steel is of the proper quality and in good condition, there need be no trouble when hardening. An experience of years in this business leads the writer to make this statement.

When handling work so diversified in character as the class under consideration, the operator should not assume that it is possible to adopt any set method which is not to be deviated from, as there is no one class of work that calls for a greater exercise of skill and common sense than properly hardening punch press dies, unless it be the hardening of drop-forging dies.

For most dies of this character, and especially those that are complicated in form, and which must retain as nearly as possible exact measurements, the writer knows of no method that will begin to give the satisfaction derived from the method known as "pack hardening," and which has been referred to so often in these articles.

When pack hardening such pieces, best results are derived from the use of a bath of raw linseed oil of the type shown in Fig. 29, in which the oil is kept from heating by pumping

through a coil of pipe in a tank of water, and then forced into the bath and through the opening as shown. If such a bath is not at hand, good results can be obtained where the oil is not agitated but the die is swung back and forth and moved up and down somewhat in the oil. If many dies are to be hardened this way, however, it is necessary to have a bath of generous proportions, or else several smaller baths, as it would not do to use the oil after it becomes hot, although oil that is heated somewhat will conduct the heat from steel more rapidly than would be supposed, and is better adapted for hardening than if it is extremely cold.

The secret of success in hardening dies by the ordinary method consists in getting as nearly as possible a *uniform* heat. To accomplish this the die cannot be heated very rapidly, as the edges and lighter portions would heat more rapidly than the balance of the piece. Unequal contraction, when quenching in the bath, follows uneven heating and unequal contraction causes the die to crack. High heats cause cracks in steel. Then again high heats render the steel weak, and as a consequence it cannot stand the strain incident to contraction of one portion of the steel when another portion is hard, and consequently rigid and unyielding. Steel is the strongest when hardened at the proper temperature, known as the refining heat.

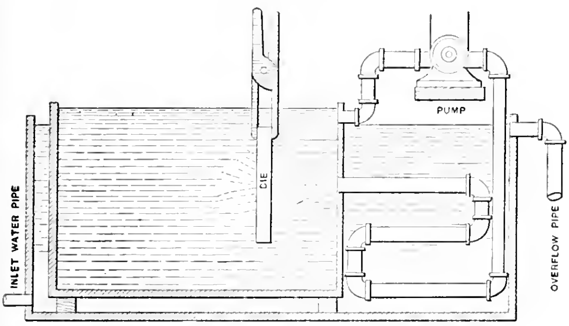


Fig. 29. Arrangement of Oil Cooling Bath.

Cold baths are a source of endless troubles when hardening dies. They will not make the steel any harder than one that is heated to a temperature of 60 or 70 degrees, or even warmer than this, but they will cause the die to spring or crack where the warmer bath would give excellent results. The writer prefers a bath of brine to one of water for this class of work, the brine being heated to the temperature mentioned above.

Have the bath of generous proportions. When the die is properly heated, lower into the bath as shown in Fig. 30, moving it slowly back and forth as shown by dotted lines, which causes the liquid to circulate through the openings, thus insuring the walls of the opening hardening in a satisfactory manner. Then again, moving back and forth brings both surfaces of the piece in contact with the liquid, causing them to harden uniformly, and preventing an undue amount of "humping," as would be the case if one side hardened more rapidly than the other. The workman must, of course, exercise common sense when doing this class of work. If he were to swing a die containing sharp corners, intricate shapes, and fine projections as rapidly in the bath as it would be safe to do were the opening round or of an oval shape, it might prove disastrous to the die, as such a shape would give off its heat very rapidly, and as a result the fine projections and sharp corners would harden much quicker than the balance of the die; and as they continued to contract the projections would fly off, or the steel would crack in the corners. To avoid this, have the bath quite warm, move the die slowly, and as soon as the portions desired hard are in the proper condition remove and plunge in a bath of warm oil, where it may remain until cooled to the temperature of the oil.

I think I am safe in saying that *most* of the trouble experienced when hardening dies is occasioned by one of two causes—possibly both. The first cause is uneven heating, the second, cold baths. I have seen hardeners plunge dies into water where it was necessary to break the ice before the die could be dipped, and then they would swear about the steel, saying: "You can't get such steel as we used to have." It is a fact, however, that at no time in the past could steel be procured that was so well adapted to the making of tools as at the present time.

The Punch.

The method of holding the punch depends on its shape and the style of die, as well as on the holders at hand in the shop. If it can be made as in Fig. 31, with a shank to fit a holder which enters an opening provided in the lower end of the ram, it will be comparatively simple to make. At other times it will be necessary to attach several punches to a holder, as in Fig. 31. When these punches can be attached to the holder by means of round shanks it will be found a satisfactory method. For many forms of punches, however, this would not answer, it being found necessary to attach them by screws, dowel pins being provided to keep them in position, as in Fig. 32 at *a*. Then, again, it is sometimes thought advisable to use a fixture for holding the punches having a dovetailed

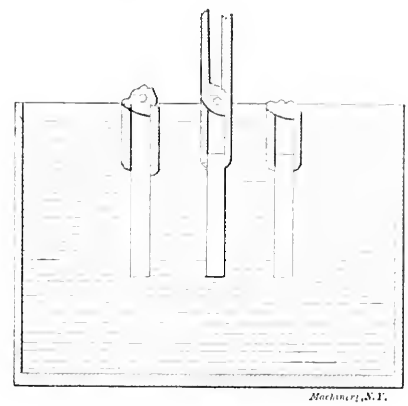


Fig. 30. Dipping the Work in the Bath.

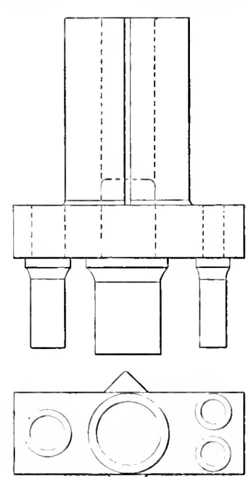


FIG. 31

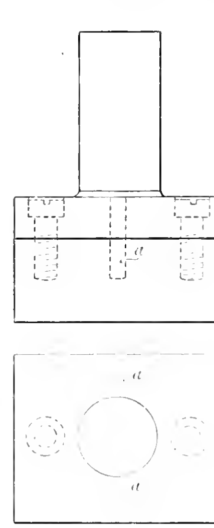


FIG. 32

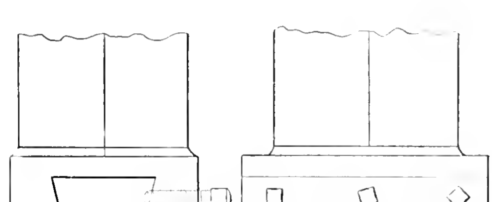
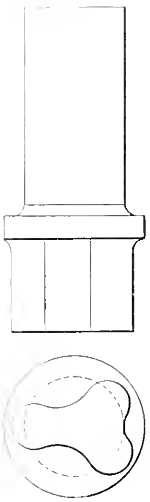


FIG. 33

Various Methods of Holding Punches.

slot cut in its face as in Fig. 33, the punches having a tongue which is fitted in the slot. The punches are securely held by means of setscrews. As the opening in the lower end of the ram to receive the punch holder of small presses is ordinarily square, the holder is made of a shape that fits the opening, the hole to receive the punch being round. At times the holder is split as in Fig. 35. When pressure is applied the holder is closed onto the shank of the punch, thus holding it securely. At other times the holder is made without splitting, and a setscrew placed in the lower end of the holder, Fig. 36. This setscrew, when screwed against the punch, holds it securely in place.



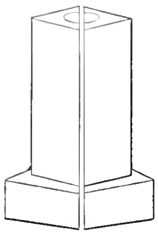


FIG. 35

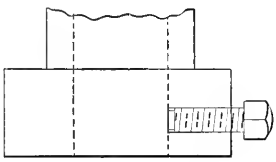


FIG. 36

Machinery,N.Y.

Fig 34. Plain Round Shank Punch. Figs. 35 and 36. Shanks for Rams with Square Holes.

It is customary to make the die, and harden it, and then make the punch and fit it to the die. After squaring the end of the punch that is to enter the die, the surface is colored with the blue vitriol solution; or by heating until a distinct brown or blue color is visible, after which the desired shape is marked on the face by scribing. If it is considered advisable to lay out the shape by means of the templet, it may be done; but if the templet is not of the same shape on its two edges, or the ends are different from one another, it will be necessary to place the opposite side against the punch from that placed against the die when marking. However, it is the custom many times to mark the punch from the die. If the die is given shear, it is necessary to mark the punch before the face of the die is "sheared." When laying out several punches from a die which has a number of impressions, it is necessary to lay out the punch from the die.

The surplus stock on the punch is removed by filing, chipping, milling or planing, as the case may be, until it is but a trifle larger than the opening in the die. The end is then cornered somewhat so it enters the opening, and the punch is forced into the die a little way. It is then removed, the stock cut away, and the punch forced in again, this time somewhat further. This method is continued until the punch enters the die the required distance. It is then filed or scraped until the desired fit is obtained. When punch and die are to be used for punching paper, soft metals, or thin stock, the punch must fit nicely. If the stock is thick, or stiff, the punch may be somewhat looser. For stock ¼ inch thick it is the practice many times to have a 1-32-inch space between the punch and die at all points. The exact amount cannot be stated arbitrarily, it being governed by existing conditions.

There are instances in which it is advisable to make punches somewhat differently from the method described. When the nature of the stock to be punched is such as to cause it to cling to the punch, making the operation of stripping difficult, to the extent that any stripper plate put on the die would be bent, or the end of the punch pulled off during the operation, the punch may be made straight for a distance that allows of grinding several times, then the portion immediately above this may be given a taper. This tapered portion of the punch is intended to enter the stock, *but not the die*. Its action is to increase the size of the opening somewhat, thus making the operation of stripping possible without endangering either the stripper or the punch.

There are various opinions among practical men as to the advisability of hardening punches. For most jobs it is the custom to do so, though there are some mechanics who consider it advisable to harden them and others who do not. There are instances where punches work well either way, and in such cases it is, of course, a matter of opinion. If good results follow the use of a soft punch it may be used, and as the punch wears it is upset and sheared into the die.

There are times when a soft die and hardened punch work well, and times when a hardened die and soft punch give good results. At other times both punch and die may be left soft. I have used very large punches and dies for hot trimming drop forgings, where both were in a soft condition and they stood up nicely. The shape of these, together with the size, made it impracticable to harden them. Then I have used punches and dies both soft, for punching light materials, and found them to give good results.

I do not think it would be advisable to state that such and such dies or punches should be hard or soft; it must be determined by the circumstances under which they are to be used, and its decision is a matter of experience on that particular work.

If punches are to be hardened—and it is generally considered best—they should be very carefully heated. It must be borne in mind that punches are subjected to great strain, consequently they should be heated uniformly, and to as low a temperature as will give desired results, thus making them as strong as possible. Heat slowly to avoid *overheating* the corners, as these are subjected to the greatest strain. The distance we should harden a punch depends on the shape and size, and the use to which it is to be put. If it is a piercing punch of the form shown in Fig. 37, it should be hardened the entire length of the portion marked *a* to avoid any tendency to bend or upset when in use. If it is of a form that insures sufficient strength to resist any tendency to upset when in use, as in the punch illustrated in Fig. 38, then it need not be hardened its entire length.

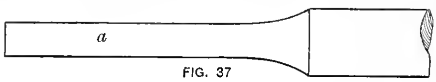


FIG. 37

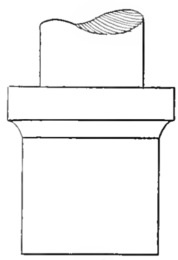


FIG. 38

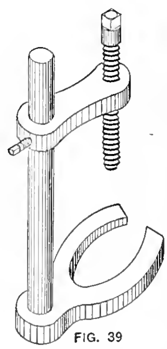


FIG. 39

Machinery,N.Y.

Figs. 37 and 38. Shapes Requiring Special Treatment in Hardening. Fig. 39 Clamp for Use in Scribing Die Outline on Punch.

Pack hardening makes an admirable method for hardening punches for most work, but for piercing punches of the type shown in Fig. 37 I do not advocate its use, as the whole structure of steel should be as nearly as possible alike. I would advocate heating in a muffle furnace, or in a tube in the open fire, turning occasionally to insure uniform results, for not only can we heat a piece more uniformly if it is turned several times while heating, but a fact not generally known is that a cylindrical piece of steel heated in an ordinary fire without turning while heating will many times show softness on the side that was uppermost in the fire, no matter what

care was taken when heating and dipping. If it is reheated with the opposite side uppermost, *that* will be found soft if tested after hardening, while the side that was soft before will be *hard*.

The smaller the punch the more attention should be given to the condition of the bath. I prefer luke warm brine. Work the punch up and down and around well in the bath to insure uniform results.

It is the custom of many mechanics to draw the temper of punches of the description shown in Fig. 37, to a full straw on the cutting end, but to have the temper lower further up the punch. Experience has taught me that better results follow if the punch is left of a uniform hardness its entire length of slender portion, as it is then of a uniform stiffness, and the liability of springing, especially when punching stiff or heavy stock, is reduced to the minimum.

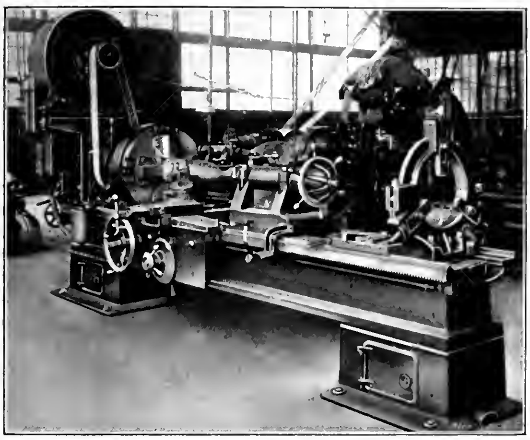


Fig. 1. Ten Horse-power Motor Operating a 26-inch Bullard Lathe; a 7-inch Projectile in Process of Turning.

It is generally considered good practice to temper the punch so it is somewhat softer than the die; then, if from any accident the two come in contact, the die will in all probability cut the punch without material injury to itself. There are exceptions to this, however. In many shops where large numbers of dies which are hardened are used, it is customary to have the one which is the more difficult to make the harder, so it will cut the other if they come in contact with each other.

In order to hold the die and punch blank firmly together when marking the shape on the face of the punch, a very convenient fixture known as a die clamp shown in Fig. 39 is used. When the two are secured by means of this clamp, it is possible to move them around so as to get at the various portions where we wish to scribe.

* * *

We hear much about the exploitation of the power of Niagara and of the enormous energy that has been running to "waste," as humanity regards it, for countless centuries. According to the utilitarian's view all that the Falls have been doing is to gouge out the canon, heat the water slightly, and for a comparatively few years furnish thrills and scenery for the tourist. Referring to the heating of the water it is worth noting how little it is heated by the successive conversions of the potential energy of the water at the brink of the cataract into kinetic energy in its fall of 165 feet and then into heat. The British thermal unit (B. T. U.) determined by Joule is the heat measure of mechanical work, 772 foot-pounds (778 foot-pounds according to Rowland) being required to raise the temperature of one pound of water one degree F. Hence, one pound of water falling 165 feet would be heated the fraction of a degree represented by 165 divided by 772, or only 0.213 degrees F. The heating is actually less than this, because of the radiation and vaporization, which latter absorbs a portion by conversion into latent heat.

* * *

About 40,000 tons of tin are consumed annually in the United States.

MOTOR DRIVE IN A PROJECTILE SHOP.

The application of motors to machine tool driving which has been made at the new projectile shop of the Firth-Sterling Steel Co., Demmler, Pa., affords a striking demonstration of what may be accomplished in increased output when such an equipment is applied in an intelligent manner. The motors are of the new type of direct-current motors manufactured by the Westinghouse Electric & Mfg. Co., known as type S A. These motors have a speed range of 4 to 1 on a single voltage, the control being obtained by introducing the resistance in series with shunt field coils. Both mechanically and electrically this type is identical in construction with the well-known S motors built by this company, with the exception of auxiliary poles and coils, a feature introduced to control the field form during the variation of field strength necessary to secure so wide a range of speed.

The auxiliary poles are bolted securely to the frame midway between adjacent main poles. The winding of the auxiliary poles is connected in series with the armature and produces a magnetizing effect which is proportional to the armature current. This introduces a factor which compensates for the distortion caused by armature reaction and field weakening. In ordinary motors the effect of armature reaction is to shift the path of the magnetic flux, weakening the leading pole tips and, consequently, shifting the neutral point, necessitating a backward lead of the brushes to obtain a field for sparkless commutation. By introducing the auxiliary poles a commutating field is maintained in a fixed position regardless of load or direction of rotation.

The motor equipment of the Firth-Sterling shop consists of eight 10-horsepower motors driving eight 26-inch Bullard lathes, two 15-horsepower motors each driving a Bullard horizontal boring machine, and one 7½-horsepower motor direct-connected to a Bullard turret lathe. The speed of the motors is varied by controllers with 21 notches, giving 21 motor speeds.

In addition to the foregoing type S A motors, a line shaft which drives a group of small machines receives its power from a type S constant speed motor.

The chief product of this plant, as its name implies, is projectiles, and the adaptability of variable speed motors to this class of work will be clearly apparent by following the successive steps in the manufacture of projectiles.

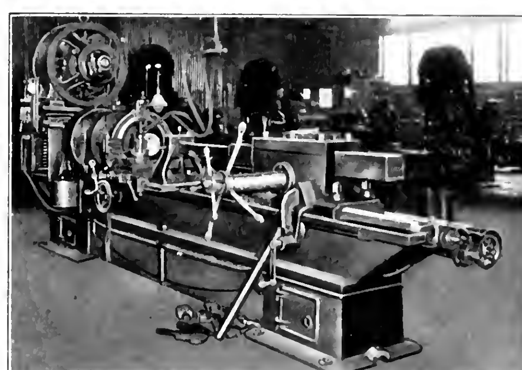


Fig. 2. Fifteen Horse-power Motor Driving a Bullard Horizontal Boring Machine, Projectile in Process of Boring Out.

The first step is the making of a steel casting similar in form to the finished projectile, but somewhat larger in diameter. After the metal has congealed it is removed from the mold and allowed to cool. The casting is then heated to a forging temperature and forged by a Bement-Miles steam hammer; when, after cooling, it is again brought to a red heat, placed in a receptacle, covered with lime and allowed to remain until entirely cool, the length of time depending upon the size of the forging. This is known as the annealing process.

After annealing, the forging is taken to the machine shop and the projection on the small end centered in a centering machine. It is then transferred to a lathe, the butt end being

chucked and the small end supported by the center in the tailstock. The machining is begun at the point of the projectile, the lathe speed being decreased with the increase of diameter by varying the motor speed, which illustrates one of the many phases of machine work where variable speed motors are exceedingly valuable, the operator being able to gauge the proper speed by watching the color of the chip.

After the lathe work is finished the partially completed projectile is placed in a cutting-off machine and the unfinished end that is clamped in the chuck removed. The work is then transferred to a horizontal boring machine where the recess or chamber for the explosive is bored out. The chamber is threaded near the butt to receive a plug, in the center of which is a smaller plug through which the fuse is inserted that is ignited by the firing charge and communicates with the explosive at a predetermined time interval, causing the projectile to burst after entering the object at which it was directed.

At two points on the barrel of the projectile the diameter corresponds to the bore of the gun and at a third point near the large end a groove is cut in the barrel into which a copper band is hammered, which, when finished, is slightly larger in diameter than the bore, causing it to engage in the rifling,

Fig. 3. View of a 7-inch Projectile Forging, Forging after Turning, and Completed Projectile.

giving the projectile a rotary motion. A groove at the butt provides a means for removing the projectile, if, for any reason, it is not discharged after being placed in the gun.

The point of the projectile is covered by a soft steel cap which, in some manner not thoroughly understood, enables the projectile to penetrate the plate with much lower velocities than are required with uncapped shells. The cap is held in place by wire driving into a recess formed by the coincidence of a groove cut in the interior with that of a groove cut out on the point of the projectile. The treating or hardening process to which the projectiles are subjected after machining is not made public.

An excellent opportunity for comparing the outputs of similar machines performing the same class of work is afforded at this plant, since in the old projectile shop of this company belt-driven lathes are still used, some with wide belts which have ample driving power. These belt-driven lathes are of the same type as the motor-driven lathes and some interesting tests of the number of projectiles finished in ten hours show the greatly increased efficiency of the motor-driven machines.

Diameter of projectile........	6-inch	7-inch	8-inch
No. of projectiles finished in 10 hours, motor-driven lathe	38	32	25
No of projectiles finished in 10 hours, belt-driven lathe..	27	27	17
Per cent. increase............	40.7	52.3	47
Average increase in output	46.6 per cent.		

The belt-driven lathes will eventually be equipped with motor drive, which is accomplished by adding an inexpensive mounting for the motor. The shop with the motor-driven machines presents a clean and light appearance; the absence of belting, with the exception of that driving the group of small machines, is a noticeable feature which naturally aids in cleanliness and gives unobstructed light, both natural and artificial.

A novel method of checking the efficiency of employees has been introduced by the Firth-Sterling Company, which is

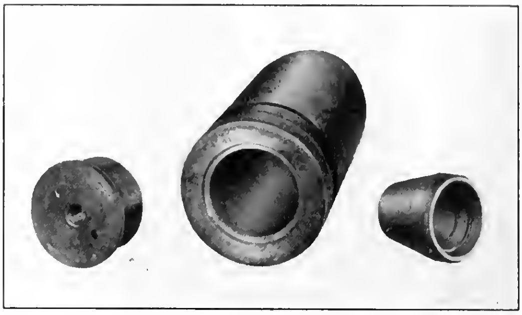


Fig. 4. View of Projectile, Plug, and Cap.

made possible by the use of electrically-driven machinery. It consists of placing in a convenient location for observation, a recording ammeter arranged to be connected in circuit with any machine whenever desired. Previous tests have determined approximately the current required for a given class of work so that the record of the ammeter indicates whether or not the machine is working up to its capacity and the time it stands idle.

* * *

One of the most complete heating and ventilating systems to be found in the country is that installed in the new U. S. Custom House now under construction in New York City. This is a large seven-story building occupying a lot 300 feet long by an average of 240 feet in width. With the exception of a small portion, an indirect heating system is used throughout. The corridors are heated by the special secondary utilization of the air after it has passed through the offices and rooms of the building, and will thus serve, with the elevator shafts, as vent outlets for all rooms heated. On account of the size of the building the heating and ventilating system was for convenience divided into four independent divisions,

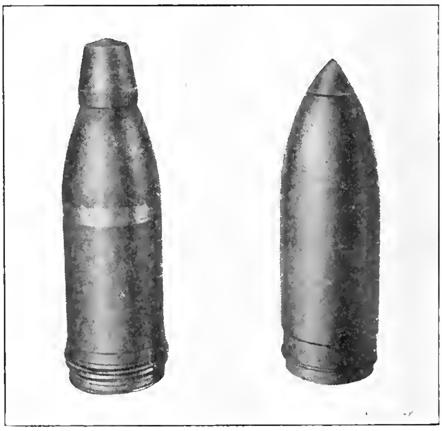


Fig. 5. An 8-inch Completed Projectile and a Projectile of the Same Diameter after Penetrating an 8-inch Armor Plate.

each serving a section of the building adjacent to one corner. Each division has an independent blower and duct system, together with air washing apparatus, tempering and heating coils, and duct work. The blowers, of which there are four, furnished by the B. F. Sturtevant Co., of Boston, Mass., are three-fourths housing, peripheral discharge, steel plate fans with 12-foot wheels, 6 feet in width. Some novel and interesting features are introduced in the way of spray chambers, tempering coils and reheaters, dry chambers, and arrangements for avoiding back drafts to the rooms, etc.

SOME ANNEALING METHODS.

E. S. WHEELER.

There has been a great deal published from time to time in regard to the heat treatment of steel, but nothing about ways and means of annealing has come to the writer's notice in MACHINERY. I have endeavored to give below a clear description of modern methods of annealing work that passes through the toolmaker's hands. The systems in vogue to-day in our large factories give toolmakers little chance of knowing how this kind of work is done, and the majority of them have a poor conception of same.

Carbon or tool steel, as we all know, is hardened by being heated to a definite temperature and then suddenly cooled; annealing is just the reverse of this process so far as the

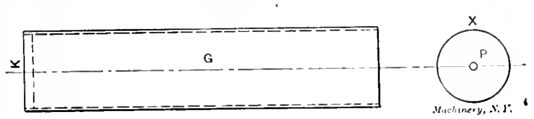


Fig. 1. A Simple Annealing Case.

cooling is concerned. The temperature of the piece (if it be a forging) should be very little above the forging heat and should be maintained no longer than is necessary to heat the mass of steel throughout uniformly. It should then be taken away from the fire and placed in a dry spot screened from

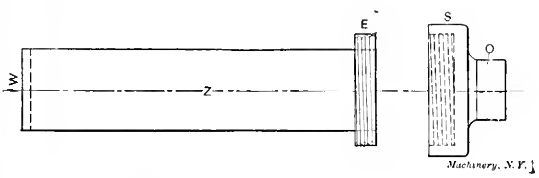


Fig. 2. Annealing Pipe with Welded Collar.

cold drafts. The slower the cooling the better will be the equalization of the stresses or strains in the steel. Annealing has the effect of throwing the carbon out of its normal combination with the iron, but all the annealing in the world will not make a steel right that has been misused previous to reaching the annealer's hands.

varies with the carbon content. When annealing forgings or pieces that have been roughed out on the lathe or shaper and where a thin layer of decarbonized steel on the surface is not objectionable the pipe shown in Fig. 1 is used.

The bottoms *K*, *W* and *L* of the annealing pipes, Figs. 1, 2 and 3 are welded in. Fig. 4 shows a good way to put a bottom in the pipe. The pipe is bored at *O* so as to make a slight shoulder from 1/32 to 1/16 inch high. The pipe is then heated and expanded enough to receive the bottom *N*, which is placed in the recess and the still hot edges of *O* are turned in onto the beveled edge of *N*. In cooling the pipe shrinks tightly onto the bottom *N* and makes a very good substitute for a welded bottom.

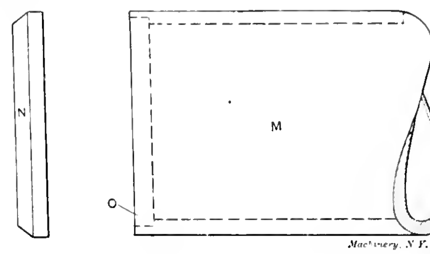


Fig. 4. Method of Attaching Bottom of Case.

In using the annealing pipe shown in Fig. 1, the bottom is filled with clean, fine charcoal to a depth of about 2 inches, and then the pipe is filled to within 3 inches of the top with the pieces to be annealed mixed with charcoal. The top is filled with charcoal the same as at the bottom, leaving a little space for a cap which is placed within the edge and luted with fire-clay. The hole *P* in the cap allows the gas formed by the charcoal to escape and prevents the cap from blowing out. Annealing by this method usually prevents the formation of a heavy scale because the charcoal takes up all the oxygen.

The pipe shown in Fig. 2 has a collar *E* welded on, which is threaded to receive the cap *S*. To charge the pipe first throw a cupful of rosin into the bottom and then put in the work and then another cupful of rosin on top, screw on the cap *S* by the square hub *O*. The cap should be threaded a loose fit so as to permit the escape of the gas. The pipe should now be placed in the fire and the rosin will be volatilized at once, fill-

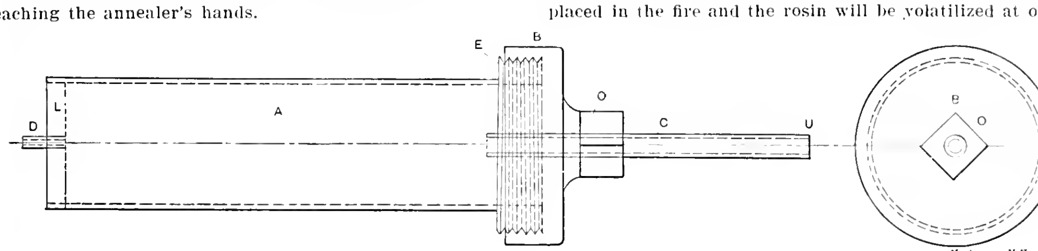


Fig. 3. Case for Use when Annealing in Gas.

There is, in general, a confusion as regards burnt and overheated steel. A steel that has been heated to too high a heat is often wrongly called burnt steel without regard to the degree of overheating. Now, overheated, burnt and perished steel are all different, being the results of different causes and showing very different properties.

Steel is overheated when, without having undergone any detectable chemical change it has been made brittle and coarse grained by excessive temperature; not having reached, however, to the fusion point, the alteration of the grain being due to mechanical causes. Burned steel is steel which has been overheated until it emits sparks and thus has had the carbon burned out of it to a certain depth and become oxidized. The oxide near the surface fuses and destroys the coadhesion of the steel. Perished steel is steel which has become soft and lost its steely nature more or less by being heated too often in the open fire to the ordinary forging temperature; or it may be caused by having been kept soaking in the fire at the forging temperature too long.

It may be well to state here that no fixed temperature can be given for annealing all grades of steel. The refining heat

ing the space around the work with hydrocarbon gases, which unite with the oxygen long before the steel is hot enough to

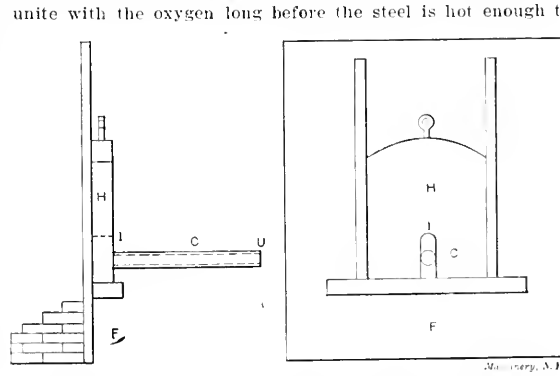


Fig. 5. Arrangement of Furnace Door and Gas Supply Pipe

be affected. The formation of gas will cause pressure and it may be seen burning as it leaks through the threaded joint at

the cap. So long as the gas is escaping it prevents the air getting in and coming in contact with the steel, and so long as oxygen does not come in contact with the steel it cannot oxidize. This process leaves the work a dark gray color covered with a fine carbon soot.

The third method of annealing is done in an atmosphere of gas but by this method the presence of a decarbonized coating or coloring of any kind is absent and it is the perfection of annealing finished pieces. Steel comes out in just the same condition as it was before being put through the heat treatment. In Fig. 3 *A* is the pipe with the welded bottom *L* and the threaded band *E* for the cap *B*. *D* is a vent pipe screwed into the bottom *L* and there is a feed pipe screwed into the cap *B*. A thread is cut on the thread end at *U* for a pipe union. In Fig. 5 *F* is the front plate of the furnace door *H*, and it has a slot *I* through which the feed pipe *C* is extended out away from the fire. Now when the pipe *A* is charged it should be placed on an iron truck such as all modern hardening and annealing rooms have, which is about the same height from the floor as the furnace door. After filling *A* with the work to be annealed the cap *B* is screwed on and a hose is connected with the gas main and then coupled to the feed pipe *C* by the union at *U*. The gas is now turned on and as it escapes at the outlet pipe *D* it is ignited, this showing that all the air has been driven out of *A* and replaced by gas. The pipe *A* is then pushed into the furnace and the door *H* is let down, the slot *I* passing down by the feed pipe *C*. The gas continues to flow through the pipe during the annealing process and by keeping the pipe down to a proper annealing heat it is obvious that the steel cannot become any hotter than the pipe. There is not a great quantity of gas consumed in this operation because the expanding of the gas in the pipe makes a back pressure, the hole in the vent pipe *D* being quite small.

* * *

LEAD PENCIL MAKING.*

There is not a very remote antiquity to the lead pencil. Some old parchments are known that were marked with lead ruling, but this must have been metallic lead. LeMoine, a writer of the year 1537, speaks of documents marked with graphite. Other writers have found papers which were evidently written with a piece of graphite inserted in the end of a stick. This shows the evolution of the pencil, beginning with the use of graphite in connection with a stick.

The first pencil factory in America was founded by a school girl. There was a graphite mine in England at that time, called the Barrowdale mine. This school girl, from somewhere obtained some of these pieces, and anticipated quite closely the pencil method of modern days. In some way she crushed the graphite, either with a hammer or a stone, and then employed gum, mixing the two together, and then cut an alder twig, dug the pulp out, and stuffed the little alder cylinder full of this gum and graphite, and thus produced the first lead pencil made in America. This took place in Danvers, Massachusetts. Later a man by the name of Joseph W. Wade co-operated with this girl, and together they made a number of lead pencils after the same fashion. The girl's name is not known.

After Mr. Wade came one Monroe, who made pencils first at Concord, N. H. They were fairly well made and answered the purpose, and became articles of commerce at that time. About the same time the well-known literary man Henry D. Thoreau, also of Concord, made pencils. Thoreau was an impecunious man, always poor, always in trouble for lack of ready money, sometimes in debt, and at one time was put in jail for not paying his taxes. After he got his pencil business started, his friends said: "Now there will be an end to Henry's poverty," but he dropped the work about as soon as he commenced it, and said he could not afford to spend his time on something that was already finished. If he could have seen the lead pencils of to-day, he would not have thought that he had worked out to its full completion the evolution of the lead pencil. This happened somewhere about 1820 or 1825, in Concord, N. H.

* Abstract of speech made by Mr. John A. Walker before the "Boost" Club, New York, May 10, 1906.

After him came a man by the name of Wood. Wood associated himself with Monroe. Wood was a very clever fellow, an inventor and originator of clever machinery, and made some circular saws and knives which he set to work on pencil making. In that way he anticipated some of the up-to-date features of the present pencil machinery.

Joseph Dixon, the founder of the Joseph Dixon Crucible Co., about this time also made lead pencils after the same system. We have some in our office yet, that he made at that time. This practically completes the beginning of lead pencil making in the United States.

To go back to England, the Barrowdale Mine was the source of the graphite, and the pieces of graphite quarried were said to be in such form that they could be sawn and pressed into the wood. It could easily be foreseen, however, that pieces of this kind were not very numerous. It then occurred to a Frenchman by name of Conte to powder the graphite and put it together with a binding material, and he worked at it until he produced the graphite part of the pencil, substantially as it is made now. Not much, however, was done with it, either by Conte or by any other Frenchman. The Germans then took it up, and while this Frenchman was the originator of this system, to the Germans belong the credit of working it out and putting it into its present shape.

Concerning the coming of the Germans to America, Faber came first in 1861; the second American factory was founded by what is known as the American Lead Pencil Co. They started in 1864. In 1868 the Eagle Pencil Co. transferred their interests here, and in 1872 the Dixon Company started. The Dixon Company sold their first pencils in 1872.

The Dixon graphite mines are located at Ticonderoga, in the northern part of New York State, and the Dixon cedar mill is located in South Florida. They are so far apart that one day in the winter of 1904, when the mercury at the graphite mines was 40 degrees below zero, the temperature at the cedar mill was 70 degrees above. These graphite mines produce about 130 tons of rock and graphite every day, and the machinery for producing this is very large and consists of an elaborate system of crushing stamps and washing mills. The graphite is carefully separated from the rock before being sent to Jersey City. The first step in Jersey City is to get all the grit out of it. It goes through the process of washing and sifting, through many machines, until it is passed upon as absolutely perfect. The clay, which is the binding material, is treated in the same way. The clay is mined in Germany. It is cleaned and made ready for the mixture by an elaborate cleaning and sifting process. By a combination of the two, the so-called lead is produced, and by the blending of the two the grades are produced. The more graphite and the less clay, the softer the pencil; the more clay and the less graphite, the harder the pencil. In this way the various grades are produced, running all the way from very, very soft, until you reach the very, very hard. The soft leads are made larger than the hard ones, to obtain in that way the necessary tensile strength. When the mixture is perfected, it is put into a very heavy hydraulic machine, the bottom of which is full of holes. Heavy pressure is brought to bear and the mixture is forced through these holes and falls into a tub below. This is repeated time after time, until judgment assures the worker that it is well kneaded. Then it is put through a similar machine, with a single hole in the bottom. As it is passed through this single hole, it comes out as strong as a shoe string. The next step is laying these leads out on a board, 21 inches long, and when dry they are cut into lengths 7 inches long, placed in a crucible, sealed up, and baked in the kiln, where the temperature reaches 2,200 or 2,300 degrees F. After being taken from the kiln they are ready then to be placed in the wood.

The colored leads go through the same process, with the exception that a China clay is used for the binding material and the pigments are used instead of graphite, to give the different colors. It is the same way also with the so-called copying leads, where aniline is substituted for the graphite.

The consumption of cedar logs suitable for pencils is going on at a greater rate than the growth. One of these days, cedar will be a thing of the past. The pencil people will have to be

fore-handed in supplying themselves with a large quantity of cedar, to protect themselves against any contingency. The product of the sawmill is what is called a slat, which has the width of six pencils, the thickness of a half pencil, and is 7 inches long. In that condition they are sent to us in Jersey City by the carload. Where the wood will not produce six pencils, it is cut into five, or if necessary four, or three, or two. The expense of gathering the cedar and cutting these slats is immense. The next step is removing the pitch from the cedar. This is done by a system of boiling, and after the boiling they are thoroughly kiln-dried. Coming from the kiln, the slat is sent to what is called the grooving machine, where in one motion it receives the six grooves. From there it goes to the table, where the leads are laid in, after which the glued other half is fitted, and then they are confined in certain clamps, screwed up tight, and left over night. In due time the blocks are released, and are now ready to go to the shaping machines. These glued blocks, as they are called, are fed in at one end of the shaping machine, and the pencils, perfectly shaped, come out at the other end, and they can be either hexagonal, round, or any shape that one pleases. The knives cut them exceedingly smooth.

From the shaping machines they go to the varnish machines, to which they are fed with a hopper. Each pencil, as it passes through the varnish machine, gets itself coated with varnish, is picked up and returned, to get a second coat, etc., until it receives as many coats as the system calls for. It will be observed that the varnish in this way varnishes also the end of the pencil as well as the sides, so they then go to another machine that trims the ends. A preliminary trimming is done first, and then the partially trimmed ends are submitted to a very sharp knife, which finishes them.

One of the most troublesome rooms in the pencil factory is where the gold leaf is laid on. It has to be a room where the air is necessarily excluded. The gold leaf is laid on, and great skill and care is exercised in getting the gold leaf cut and laid on properly on a round or hexagonal pencil. The pencils are then conveyed to stamping machines, and the letters of the die are stamped into the gold. After the impression is made on the gold leaf, the surplus gold is rubbed off, and then we have the stamped letters as you see them on the ordinary pencil.

LUNCH ROOM AT THE ROCK ISLAND ARSENAL.

ALBERT D. KNAUEL.

That the Government is progressive is shown by the establishment of a noon hour lunch room at the Rock Island Arsenal, Illinois, for the accommodation of the employees.

This lunch room is conducted on the co-operative plan, the men having founded an association known as the Rock Island Arsenal Lunch Association. The officials are composed of men selected from the different departments to act as an executive board, with the approval of the commanding officer, Col. S. C. Blunt, Ordnance Department, U. S. Army.

A chef is employed to do the cooking, with eight assistants for waiters. The meal ticket, Fig. 1, is issued to each member semi-monthly, for which he pays ten cents a meal.

On the back of the ticket are printed the following rules:

This ticket is sold only to employees of R. I. Arsenal and is good only for the person to whom it is issued. Only in case of sickness or unavoidable absence from work of two or more days, or in cases of discharge or resignation, will the holder be entitled to rebate.

Members of the Association are expected to conduct themselves in an orderly manner while in dining room. Each member is requested to remove his hat at the table. Throw-

Fig. 1. East Wing of the Lunch Room at the Rock Island Arsenal.

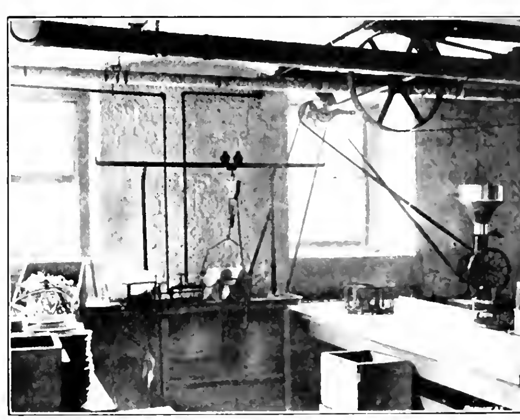


Fig. 2. Power-driven Dish Washer and Coffee Grinder

ing food or coffee on the floor will not be allowed. Members are entitled to one cup of coffee or milk each day. All complaints should be made to the manager.

By order of the Dining Room Committee.

In the view, Fig. 3, is the kitchen, in which may be seen to the right, the steam coffee urns, and to the left, the soup boilers. This is a well appointed kitchen, all the utensils used being made at the arsenal. Fig. 2 shows the power dishwasher and coffee-grinder. Fig. 1 shows the line of tables, in the east wing, set for dinner.

The entire east wing and south bay of the basement of Shop B is used for the dining room. There are 75 tables seating 1,200 men but at present only 600 men are served. About 125 gallons of coffee, 120 gallons of soup and 250 loaves of bread are consumed daily.

Fig. 3. View of the Kitchen.

The bill of fare for one week consisted of: Coffee or milk, bread and butter; sliced corn beef, vegetable soup with crackers, corned beef hash, Frankfurters with potatoes, rice soup with crackers, cold sliced beef with potatoes and other variations, all for ten cents a meal.

The association owes much of its success to Colonel Blunt whose efforts to bring this movement to a permanent standing were unceasing.

* * *

One of the curious discoveries made in connection with windmills is that a wheel composed of slats closely spaced will not develop as much power for the same area as one wherein the slats are openly spaced, that is, with considerable distance between them. This fact was discovered accidentally by Sorensen in making some windmill experiments when part of the vanes of the mill on which he was working were carried away. Much to his surprise he found that the wheel developed more power than before. Thereupon a wheel with only six vanes was built and this developed more power under the same conditions than could be obtained from the "ventocrat" or "rose of the winds" systems. The later development of the Sorensen wheel arranged the six vanes on the surface of a cone with the tips of the vanes flared slightly forward, the apex of the cone being presented toward the wind. In this connection it is asserted that a board fence in which the boards are closely set together will not blow down as quickly as one in which the boards have considerable space between them.

10 **R. I. A. Lunch Association** 9

11 8

Limited Ticket—Not Transferable

12 *For Employees—Rock Island Arsenal only* 7

13 Issued to Mr.................................... 6

14 5

From .... To....................

15 4

No.................... THIS TICKET GOOD FOR ONE MEAL ON DATES HEREON WHEN STAMPED BY MANAGER

16 3

17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2

Fig. 4. The Meal Ticket.

GLUES AND CEMENTS.

We have seldom met with a more useful handbook than Mr. H. J. Cassall's shilling volume on "Glues and Cements," just published at the *Bazaar* office, Drury Lane, W. C., by Mr. L. Upcott Gill, says the *English Mechanic*, and the following quotations from the book are appended:

"Cements and adhesives are of many different classes. First, there are those which are always ready for use, and which need no preparation of any kind. Such are the 'liquid glues,' ordinary office gum, the pastes, etc. The second class takes in those kinds which are ready so far as mixing is concerned, but require some preparation such as heating before they are soft enough to use, and of this class the most representative variety is common glue. A third section comprises those which need some liquid added to the stock of compound to fit them for use, and a fourth includes those which require to be made up every time one of the class is needed. Of all these there are many varieties, applicable to different conditions and substances, and most of them are further divisible into adhesives and cements.

"Broadly speaking, the difference between an adhesive, or glue, and a cement is this: an adhesive is for use when the surfaces to be joined coincide more or less exactly, and consequently such surfaces hold together almost directly. A cement, however, is for use where there are irregularities in the surfaces which are to be joined, and these must be filled with the joining medium, which holds onto itself as much as to the surfaces being fixed. A cement, in fact, first makes a surface by filling up irregularities, and then acts as an adhesive.

"Thus, in joining porcelain which is newly broken but unchipped, and in which, therefore, the two surfaces, although irregular, coincide exactly, the best job will be made where there is as little glue as possible used, for the closer the broken edges are together the better they will hold. The cement or mortar which is used for a wall, however, has first to fill up all the irregularities and holes in the bricks, for such irregularities are not coincident, and the wall holds together not because one brick holds to the next, but because it has had attached to it a coinciding surface of cement in the first place, and the brick under it has received the same, so that it is the brick and its layer of cement which hold to the next layer of cement and its brick. It will be obvious, therefore, that such a cement when set should be as strong as the substance joined. Although this is not recognized in the practice at least of the present day, whatever it may be in theory, yet both practically and theoretically was it carried out by the builders of olden times. They made their mortar so much stronger than we do now that in many old buildings we can see that the bricks have decayed through the action of time and weather, leaving the still intact mortar standing out like a grid.

"But the scientific method of classifying adhesives and cements should be in accordance with their mechanical actions. Their setting depends upon various causes, and if these are not present they cannot set, but will remain liquid or soft for ever. This is an extremely important point, because although a particular adhesive or cement may be the very thing when applied to two substances under some conditions it would be quite useless under others, because the special conditions under which it hardens will not be present. For instance, ordinary glue will stick tightly on most metals if they are chemically clean. But its mechanical action—that is, the method by which it sets—depends mainly upon evaporation of the water contained in the glue. If, therefore, we attempted to glue together two pieces of metal with this adhesive, only the edges where the air could get at it would dry—the central part could never evaporate, for the metal is non-absorbent, and as the glue at the edges would become hard first the water could not get away between them.

"This is merely an example of our point that the methods of setting of various adhesives have to be taken into account when using them. As this book is not merely a string of recipes of glues and cements, we shall mention the various mechanical actions upon which such substances depend for their efficiency, for the reader, if he can master those princi-

ples, will be able to compound his own cements to suit anything or any combination, whereas it would be all but impossible to give every glue and every cement which can be made, and which can be applied to every condition. The most ordinary method by which an adhesive hardens is, of course, by evaporation. Of such adhesives glue is the commonest, and the sticking agents compounded of spirits and rosins act in the same way. A second method is by cooling. Typical examples of this are sealing wax, the marine glues, pitch, etc. Thirdly, there are those which depend upon absorption of something from the air. Common mortar is among these. Its action is purely chemical, and it depends upon absorbing from the atmosphere carbonic acid gas. Others depend upon taking oxygen from the air, and thus oxidizing themselves into a different substance which is hard and tenacious. White lead is such a cement, the linseed oil in this instance being the medium which changes by oxidation into a hard substance (very much akin to India rubber from a chemical point of view) that binds the particles of the white lead together. Then, again, there are cements which depend upon absorbing water from the atmosphere instead of giving it out by evaporation; others are mixed with water and combine with it, changing their structure in the process—*e.g.*, Parian cement and plaster of Paris; and there are yet others the ingredients of which combine together to form something different without any help from the air, or the water, or the carbonic acid gas therein contained. It is important to take the above points into account when joining things by adhesives, and it is for this reason that the subject has been somewhat enlarged upon."

* * *

THE GROWTH OF THE TRADE PAPER.

The newspaper has a long history and although its development within the last 30 or 40 years has put the older efforts so far into the shade as to make them appear very puny, the followers of the "news letter" are essentially the same in principle as their progenitors. It is true the telegraph has supplanted the stage coach and the perfecting press the hand press of Benjamin Franklin's time but the gathering of news and gossip of ephemeral character and its dissemination is still the function of a newspaper and will so continue to be. The oldest publication in The United States, originally a newspaper, is the *Saturday Evening Post*, founded in 1728 by Benjamin Franklin. Now it is a special publication filling a place between the newspaper and the magazine. It is rarely that a daily paper can present an article which reviews and summarizes a situation and points the trend of progress or draws a conclusion. A valuable feature of the publication referred to is that it presents articles which review conditions, marshals together related facts and gives the readers in a few words a grasp of a situation which they could scarcely ever get by reading newspapers. An article contained in the May 12-19 issues is on what the author is pleased to call a new profession, and that is editing and writing for trade papers. The trade paper, as we all know, is a comparatively new idea in journalism, strictly class papers being few that have an age greater than 25 or 30 years. But there are now hundreds of trade and class papers devoted to almost every trade and profession, some of which have a standing, capitalization and organization which rival that of small city newspapers. The writer of the article, Mr. James H. Collins, believes that the possibilities in trade journalism are considerable and that the business is one that affords many opportunities to the trained writer who also has technical knowledge. He says in part:

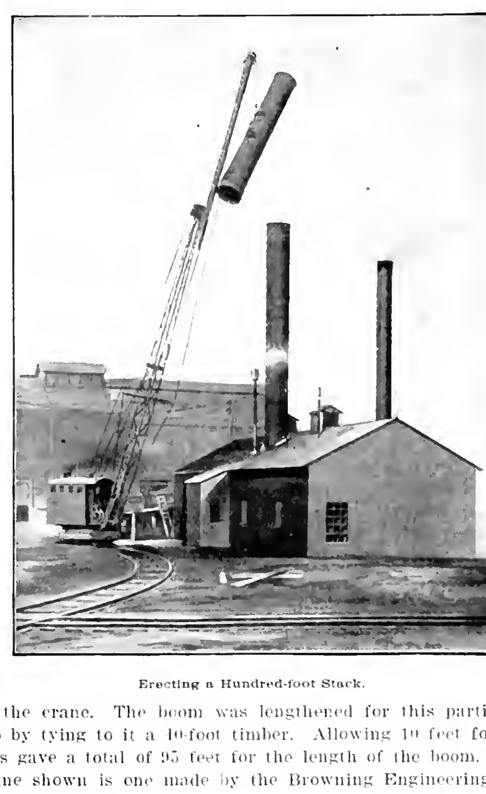
"But while the trade journal has been developed phenomenally on its business side, its editorial growth has been less rapid. The newspaper and the magazine have certain literary traditions and heritages that have come to them through a long period of development. The trade journal has none. Each publication of this class, coming into a technical field that had never enjoyed a medium for the spread of information, was forced to make its own methods. And in the development of its editorial policy literary skill was usually unavailable. Engineering journals grew out of the prolix official report. Publications launched to keep a retail trade informed on prices, new goods and shop methods, were written by merchants and clerks. Contributions to journals dealing with machinery came from mechanics and foremen. One by one new trade fields were furnished with their especial journals, written from their especial viewpoint, in their own technical patois. To the newspaper and magazine writer these were Greek. But because the trade journals were written with yardstick and calipers, and illustrated with the blueprint, they had vitality. The exact information of engineers' reports, in which everything is stated with three synonymous adjectives, gave a basis upon which to build more direct articles. Journalistic and literary standards seem fatal to a trade periodical at the outset, but after the special field and patois have been defined by technical men, the trained general writer is often able to grasp them, shape a wider policy, vary subjects that trend toward set channels, and employ literary artifice not only in presenting matter more attractively, but in getting fuller, fresher information. For the technical half knowledge of a trained writer is often precisely the element needed to reveal and exploit points, that in the technical man's judgment, seem commonplace.

"The number of trade journals in the United States is now estimated at between fifteen hundred and two thousand. About four hundred and fifty are published in New York City, which has fourteen daily newspapers devoted to finance and commerce; seventy weekly and monthly periodicals to finance, commerce, insurance and markets; seventy-five to iron, steel, manufacturing, mining, building, and wholesale trade; thirty-eight to railroads, electricity, engineering and machinery; sixty to law, medicine, pharmacy, architecture, science and education; fifty to literature, art, music, the drama, publishing and advertising; fifty to retail trade; forty-three to sports, fashions, agriculture, etc., and fifty of miscellaneous character."

* * *

ERECTING A HUNDRED-FOOT STACK WITH A LOCOMOTIVE CRANE.

The locomotive crane shown in the halftone is engaged in a somewhat unusual task, namely, that of placing in position the upper section of a steel stack which, when completed, was fully 100 feet in height. The section being handled weighed 4½ tons and was swung at a radius of 25 feet from the pivot



Erecting a Hundred-foot Stack.

of the crane. The boom was lengthened for this particular job by tying to it a 40-foot timber. Allowing 10 feet for lap this gave a total of 95 feet for the length of the boom. The crane shown is one made by the Browning Engineering Co., Cleveland, Ohio.

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MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1906.

PAID CIRCULATION FOR JULY, 1906,—22,114 COPIES.

MACHINERY is published in four editions. The practical work of the shop, is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature; and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A correspondent somewhat unkindly defines "toolmaker" and "mechanical engineer" as a machinist and draftsman respectively who have become afflicted with "swelled heads." A strictly technical definition of a swelled head is not at hand, but taking it in the sense of having a large opinion of one's self, and not as a condition of mere bumptitiousness, it is not quite so bad as it seems. To illustrate: A mechanical engineer is, in general, simply a man of good judgment and some mechanical ability, mixed with training, a knowledge of general practice, and—not least—a good opinion of himself. In short, he has confidence in his own ability and that confidence entitles him to the confidence of others. No man can expect to have others believe in him unless he believes in himself. A good machinist who thinks that he is able to make tools generally ends by making them and then he is entitled to be called a toolmaker—so there you are.

* * *

ONE EFFECT OF INERTIA.

The tendency of water in motion to continue in motion in the direction in which it moves, or in other words, its tendency to move in a straight line, sometimes is the cause of disastrous results and sometimes may be taken advantage of by one who bears this principle in mind. An engineer recently expressed himself as averse to the use of separators for extracting water of condensation from steam supplied to a steam engine because at best they are bound to break up the water into particles to a greater or less extent which are likely to become entrained with the steam and enter the engine cylinder with it. He contended that it was never necessary to use a separator because the piping could always be put up in such a way that the steam would free itself of this entrained water. His plan was to continue the steam main a short distance beyond the point where the vertical pipe connecting with the engine led off from it; and then connect a short vertical pipe, closed at the bottom, to this extension of the main line, its purpose being to act as a pocket for any water that might collect. When a slug of water came over with the steam it would shoot by the vertical pipe leading to the engine and continue in a straight line to the reservoir at the end of the main pipe, where it would be collected. The steam would turn the corner and travel down to the engine, but the water would not and so would be effectually eliminated.

As a further illustration of this principle may be cited the case of a certain steam engine which had a way of knocking off its cylinder head, owing to water entering with the steam. The cylinder was provided with relief valves placed near the heads in the cylindrical shell of the cylinder, after the usual custom, but they were of no avail and repairs were necessary a number of different times. It was finally suggested that one of the relief valves be placed in the center of the head end of the cylinder, since it would be more apt to act effectually at this point than at the side of the cylinder. The experiment was successful. Whenever water accumulated the pressure was instantly relieved in the cylinder by the opening of the relief valve and no more trouble ensued. As the piston advanced the water lying on the bottom of the cylinder would be driven in an upward direction against the cylinder head and the relief valve at the center of the head was directly in the line of the moving water, while the valve in the usual place at the side of the cylinder is quite out of the path of the water. If the relief valves are to be located in the walls of the cylinder at all, they would very likely be more effective at or near the top of the cylinder than at the side.

* * *

THE ADVANTAGES OF GOING SLOW.

It is possible that some of our readers have been amateur farmers at some time or other. If this is the case, it is also possible that they have been, like most of the tribe, impressed with the comparatively large returns that were obtained from the flock of fifteen or twenty hens which kept the family supplied with eggs. Perhaps some of them, charmed with the prospect thus presented, went into the business quite heavily, only to find that the aforetime cheerful and productive hen, when exploited on a large scale, developed an alarming appetite for a bird of its size, and evinced therewith no great anxiety to give an adequate return for favors received. A little thought would have convinced the experimenter that the feed bill per hen per month is bound to be greater with the large flock than with the dozen fowls who lived mostly on kitchen scraps and the bugs from the neighbors' lawns.

But there are other industries besides hen farming in which men have discovered to their sorrow that wastes and leakages which are invisible when business is done in an experimental way, develop to such an extent as to make the venture unprofitable when carried out on a large scale. In a western city some little time ago the writer noticed a plant composed of concrete buildings put up in a solid and substantial manner, evidently not many years old, which yet gave evidence of not having been used for many months. On inquiry it was found that the plant had been erected by a local lumber manufacturer who conceived the idea of using the sawdust and waste developed by his factory in the production of wood alcohol. An expert chemist was hired, and in due time an experimental plant was built in which the waste was successfully utilized for the purposes desired. So far as the manufacturer was able to determine, the alcohol made in this experimental plant was produced at a very fair profit, and the prospect seemed so bright for making money from what had hitherto been a dead waste, that he at once proceeded, under the advice of the expert chemist, to build a plant of sufficient size to take care of the entire output of refuse from the mills.

This plant, however, did not work, and it stands to-day a monument to the failure of this man to carefully analyze the conditions under which his experimental apparatus was operated. Many expenses which before had seemed to be so slight as to be negligible, became important factors in the larger plant. The items of repairs for the apparatus, the cleaning of the various vessels, stills, etc., and the rapid deterioration of some portions of the equipment, were factors with which he had not reckoned. The chemist, either from design or from inability to appreciate these points, had not enlightened his employer on this subject, so the project ended in absolute failure. The ability to analyze conditions from experiments on a small scale is a comparatively rare gift but it is a very necessary qualification for one who plans to embark on an enterprise with whose details he is not very familiar.

SOME EVILS OF EXTREME SECRECY.

When the Pennsylvania Railroad Co. let the contract for building its tunnels under the Hudson and East rivers, one of the stipulated conditions imposed on the contractors was that they should give absolutely no information whatever to the public as regards the progress of the work, the methods of construction, the difficulties encountered, or anything in the way of gossip regarding the work. Why such a gag should have been imposed is not clear. Although the tunnel under the Hudson River was of a type never before constructed, we believe its design in all essential features was necessarily made public in the plans which had to be submitted to government, State and municipal authorities, and so far as we know nothing expected to be encountered in the construction work was of a nature that necessarily called for secrecy. Whatever may have been the expected benefit, we do know that the policy of secrecy has been detrimental to the standing of the company and contractors. In the absence of exact knowledge, the newspapers have published exaggerated reports, alleging that large numbers of the workmen died of the caisson disease known as the "bends," and asserting that the work had met with such enormous difficulties that it is very doubtful if it could be prosecuted under the East River so as to complete the four bores within the contract limit of two years. So insistent became the clamor that finally the officials of the company were induced to remove the gag of secrecy and allow Mr. E. W. Moir, of S. Pearson & Co., the English contractors, to give out a statement of the actual conditions. He expressed the situation very graphically, saying: "I am working with my hands tied behind my back. People can say whatever they want about us, and we cannot tell the truth. We do not like the gag that has been put upon us."

As a consequence of Mr. Moir's extended statement published in the daily press, and the fact that the tunnel work has since been inspected by engineers and others competent to judge of the conditions, it is now believed that the tunnel conditions are not nearly so bad as was the popular impression. The work is only about two months behind, and instead of there being something like one hundred deaths from bends there had been fourteen at the time of the statement. This number is fourteen too many, of course, but it is not due, according to Mr. Moir's statement, to lack of precautions on their part, but is owing in some degree to the men going out through the mud locks to save delay instead of through the regular exit, in which the pressure is gradually reduced, and to the presence of injurious gases in the tunnel coming from the East River mud. This latter seems a somewhat doubtful statement, but even so, the point to be made is that the public attitude toward the tunnel work will be quite different if a reasonable amount of information is given as to the progress, and the nature of difficulties undergone, and if it is known that all precautions possible are taken to prevent disease and accident. No one likes to think that any corporation or contractor is prosecuting a work in which men are needlessly killed, and in work like this of an extremely hazardous nature it is a very poor policy to follow any other but one of frank expression of the actual facts.

* * *

THE ARMOR PLATE SITUATION.

Up to two or three years ago the so-called armor-plate trust, consisting of the Carnegie and Bethlehem Steel Companies, supplied the armor plate for the United States battleships with practically no competition. The Midvale Steel Co. then erected an armor-plate plant at Nicetown, Pa., and entered the field as a competitor. The recent opening of bids for armor to be furnished for the new battleships *Michigan* and *South Carolina* demonstrated that the power of the trust has been broken, as for the first time in years the bids of the Carnegie and Bethlehem Steel Companies were different. The bid of the Midvale Co. was the lowest, the price being $345 per ton, with the exception of the bolts and nuts. The Carnegie bid was $370 per ton and that of the Bethlehem Co. $381 per ton, the former of which represents a drop of $92 per ton since the competition entered the field. The representatives of the latter company, finding they were underbid, made such strong protestations to Secretary Bonaparte that the contract for over 7,300 tons was finally divided, half going to the Midvale Steel Co. and one-fourth to each of the others. It was considered that in the event of the armor trust not getting any portion of the contract their plants would have to shut down, thus throwing their skilled workmen out and disrupting the organizations. The strategic importance of keeping all our armor plates in working shape was recognized, and much as the officials of the Navy Department might have wished to punish the erstwhile haughty trust it was not thought best to give the whole contract to the Midvale Steel Co. Moreover, there was some doubt as to its capacity being sufficient to fill the order as rapidly as it might be required. The situation at the present time is gratifying, but there is a suspicion that the present competition will not long exist, for probably strenuous efforts will be made to effect a combination and thus restore the monopoly.

* * *

Periodically the trouble comes up of contributions being sent to more than one publication, in syndicate style, and evidently in imitation of the practice of certain newspaper correspondents. While such practice may be allowable in newspapers which have a circulation restricted to a certain section it is by no means so with magazines and journals like ours, which have a world-wide subscription list. It seems very strange that some of our well-meaning contributors do not recognize property rights in contributions the same as they would in any other article for sale. When a contribution is sent to MACHINERY for pay it is expected to be exclusive, the same as if title were being given to any other piece of property, and the contributor has no more right to sell it twice over than he would to give the title twice to a piece of land. This principle is recognized in law as including manuscripts and a statute is in force intended to protect publishers from such imposition; but we always assume that it is done in ignorance. It, nevertheless, is very exasperating to prepare an article, make the cuts, and get it ready for publication, and find that the same article has appeared in another journal. It means that we lose the cost of the cuts and composition, and the time required for the preparation. Sometimes, as it has happened in the past, the article appears simultaneously and then there is nothing to do but refuse payment, a proceeding which we do not relish, but which seems about the only thing to do.

* * *

There has been some confusion as to the correct term to apply to alcohol which has been rendered unfit for drinking purposes without destroying its value for other uses. The report of hearings before the Congressional Committee of Ways and Means designated alcohol so treated as "denaturized," which form we have used, but the Standard dictionary in the latest edition gives preference to the form "denatured," with "denaturized" as the variant. The preferred form has the merit of simpler spelling and easier pronunciation; it is regrettable that the more cumbersome word has gained currency, for changing to the other may be slow, especially as it has received official recognition in government transactions.

* * *

An error occurred in the first paragraph of the article "Free Alcohol and its Effect on Industrial Conditions" in the July issue; it stated that the calorific value of ethyl or pure alcohol is about 28,500 B. T. U. per pound. The authority for this statement was found in "The Gas Engine," by F. R. Hutton, but this figure is over two times too large, probably being the calorific value for 1 kilogramme, inasmuch as the value of pure ethyl alcohol is from 11,000 to 13,000 B. T. U. per pound. Consequently the figures following the statement in this paragraph are also erroneous.

* * *

The formula for horsepower transmitted by belting in the article by F. Wackermann, July Engineering Edition, had for a denominator 500, whereas it should have been 550, thus making the formula as follows:

$$HP = \frac{(T - 0.012\,V^2)\,V}{550}$$

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Pacific Coast Railway Club, Oakland, Cal., have made announcement that, since the destruction of San Francisco by the great earthquake, April 18, it has held no meeting on account of the unsettled condition of affairs, and it has been decided that all club business will be suspended for the present.

The immense trade of Hamburg, Germany, is indicated by the fact that the sea-borne merchandise exported and imported during 1905 amounted in all to 17,374,218 tons, with a value of $1,268,161,000. As compared with the preceding year, this shows an increase of 1,500,000 tons in volume and of $123,900,000 in value. The main increase was in the imports, but exports also exhibited a substantial advance.

This is the way MACHINERY'S shop receipt No. 171 appears after being revised and put through Andrew Carnegie's spelling reform by the *Engineer:* "For cementing leather belts, 1 pound of good fish glue should be soaked over night in a pint of cold water and then heated and stirred until the glue is entirely dissolved. Add 1 ounce of dry white lead and after mixing thoroly, when nearly cool, add 1 ounce of grain alcohol. The cement should be heated when wanted for use. This cement is to be brusht onto freshly cut surface and clampt together by the use of boards on each side and allowed to dry for an hour or two."

A brief report of the progress of the "Technolexicon of the Society of German Engineers" has been received from the editor-in-chief, Dr. Hubert Jansen, Dorotheenstrasse 49, Berlin (N. W. 7). This ambitious work, which has previously been noted in MACHINERY, was commenced in 1901, the object being to compile a universal technical dictionary for translation purposes in the three languages, English, German, and French. In June, 1906, over 3,000,000 word cards had been collected, these being the work of 2,000 firms and individual collaborators at home and abroad who are assisting in the compilation. The work has so far advanced that printing will be begun by the publisher, J. J. Weber, Illustrierte Zeitung, Leipsig, Germany, some time in 1907.

The great floating drydock, the *Dewey*, which was built in the United States, for the naval station at Manila reached its destination in the early part of July after a trip covering 12,000 miles and requiring a period of nearly six and one-half months. It was considered by some to be a hazardous undertaking to attempt the conveyance of the drydock half way around the earth by towing. The successful outcome is undoubtedly due to the use of the steam towing gear, a device which has come into general use on ocean-going tugs during the past few years. This gear minimizes the stress on the tow-line by paying out and hauling in the cable so as to keep a nearly constant pull at all times, irrespective of the pitching of the two vessels. The *Dewey* went by way of the Suez Canal, leaving Solomon's Island, in the Chesapeake Bay, December 23. Notwithstanding the use of the steam towing gear, heavy storms parted the cable twice, but in each case the structure was recovered without sustaining damage.

The Supreme Court of Vermont has established a principle of vital importance to labor unions in that State, and that is the individual responsibility of the members of a union for losses caused to a concern by a strike. As the result of a strike in Rutland, Vt., a manufacturing concern in that city lost $2,500. The company brought suit against the union for compensation and got a judgment for the full amount. The case was appealed to the supreme court, which upheld the judgment, but the company was unable to collect the money as the union's treasury had no funds. Thereupon suit was brought against the individual members of the union under a provision of the State law which provides that judgment may be collected from the individual members of any association when it is composed of five or more members. This case was won by the company and upon being appealed the supreme court again sustained the judgment. Hence, the individual members of the union will be required to compensate the company for the amount of the damages as individuals.

Rails 331 feet long were exhibited at the International Exhibition held at Liege, Belgium, in 1905. These included an 85-pound grooved girder rail for street railway track, 331.28 feet long, and a 70-pound tee rail of the same length; also a light tee rail 252.56 feet long, of only 7 pounds per yard, for portable railway track. The two large rails were each made from a 5½-ton ingot, heated 1½ hour in the soaking pit to insure a uniform temperature throughout the mass. This was rolled in a rolling mill having blooming and finishing mills driven by an engine of 10,000 H. P.; the rail was rolled in five minutes, and was exactly 354.24 feet long, the ends being cropped to make a first-class rail of 331.28 feet. Owing to the restricted space, the rail, as it passed through the rolls, traveled up a steep inclined plane and over the top of a two-story building. When the rolling was finished, and while the rail was still at a bright red heat, it was attached to a locomotive which hauled it along the ground about 650 feet to a place where it could be left to cool slowly. These rails, as well as two tires 16.4 feet diameter, were exhibited by the Ougree-Marihaye Co. of Belgium.—*Engineering News.*

TEMPERING BY MEANS OF METALLIC BATHS.

The following list of alloys, numbered to correspond with the list of tempering heats, is given in the *Practical Engineer.* The colors corresponding to tempering heats are as follows.

	Degrees F.		Degrees F.
1. Light straw	430	6. Light purple	520
2. Straw	450	7. Dark purple	530
3. Dark straw	470	8. Bright blue	550
4. Light brown	490	9. Blue	560
5. Dark brown	510	10. Dark blue	600

Corresponding to these temperatures are the following alloys, which melt at the temperatures shown below, but in getting them fluid a few more degrees of heat are usually required:

	1	2	3	4	5	6	7	8	9	10
Lead (parts)	15	17	10	14	5	25	30	12	25	95
Tin (parts)	8	8	4	4	1	4	4	1	1	1

These alloys should be carefully made and then run into small strips of about ½ inch square, being afterward remelted. The pan should be carefully heated by gas if possible, and the metal should only be heated to such a point that the insertion of the tool causes it to set round the steel. When such is the case the steel becomes equally heated as the metal melts, and it can be allowed to remain some time in the metal before taking out and quenching. Another plan is to lay the tools on the cold alloy and allow them to remain until it melts, this permitting the steel to gradually warm through, and possibly giving better results in the hands of some men. Usually, however, the plunging of the tools into the molten metal is the method adopted, and provided time is given to allow of the absorption of heat to a sufficient depth, this gives good, tough tempering with the requisite hardness.

PERMISSIBLE LOADING FOR KNIFE-EDGES.

Loads of 10,000 pounds per inch of length on knife-edges for scales and testing machines, are permissible, says Mr. Joseph W. Bramwell in the *Engineering News*, but the pivot must be flat at its upper portion, normal to the load, and supported its whole length, with a minimum deflection of parts to insure reasonable accuracy. The quality of steel used in pivots and seats has an important bearing upon the allowable load. In all cases it is essential that a high-grade, uniform tool steel be used, having a carbon content of 0.90 per cent to 1.00 per cent. Such steel will take a very high temper and

yet have sufficient ductility to resist sharp blows without crumbling. The temper of the seats should be drawn to a very light straw color; that of the pivots should be slightly darker. For accurate results it is very desirable to know the heat which must be used to produce the proper hardness. The angle of 90 degrees for the knife-edge has given good results for heavy loads. For ordinary weighing machinery and most testing machinery 5,000 pounds per inch of length will be found an ample allowance. In a recent testing machine of 800,000 pounds capacity, made from the writer's designs, the two large levers had a load of 10,000 pounds per inch on the pivots for the maximum load. Each pivot had an effective length of 40 inches. The edge may be made perfectly sharp, for loads up to 1,000 pounds per inch of length. For greater loads the sharp edge is rubbed with an oilstone, so that a smoothness is just visible. A pronounced radius of knife edge will decrease the sensibility of the apparatus. The seat, if an angular one, is shaped with a small radius at the intersection of the sides of the angle.

Fig 1.

Fig 2.

Fig 3.

Fig. 4

Fig. 5

Fig. 6.

The Genesis of the Binder Knot.

THE EVOLUTION OF THE CORD-KNOTTER OF THE SELF-BINDING HARVESTER.

Extract from Paper: "The Art of Inventing," Mr. Edwin J. Prindle. Read at the A. I. E. E. Convention, Milwaukee, May 28-31, 1906.

A most interesting example of the evolution of an invention is that of the cord-knotter of the self-binding harvester. The problem here was to devise a mechanism which would take the place of the human hands in tying a knot in a cord whose ends had been brought together around a bundle of grain mechanically. The first step was to select the knot which could be tied by the simplest motions. The knot which the inventor selected is that shown in Fig. 7, and is a form of bow-knot. The problem was to find how this knot could be tied with the smallest number of fingers, making the smallest number of simple movements. As anyone would ordinarily tie even this simple knot, the movements would be so numerous and complex as to seem impossible of performance by mechanism. The inventor, by study of his problem, found that this knot could be tied by the use of only two fingers of one hand, and by very simple movements.

The knot will best be understood by following the motions of these fingers in tying the knot. Using the first and second fingers of the right hand, they are first swept outward and backward in a circular path against the two strands of the cord to be tied, as shown in Fig. 1. The fingers continue in their circular motion backward, so that the strands of the cord are wrapped around these fingers, as shown in Fig. 2. Continuing their circular motion, the fingers approach the strands of the cord between the twisted portion and a part of the machine which holds the ends of the cord, and the fingers spread apart as shown in Fig. 3, so that they can pass over and grasp the strands thus approached, as shown in Fig. 4. The fingers then draw back through the loop which has been formed about them, the fingers holding the grasped portion of the strands, as shown in Fig. 5. The knot is finished by the completion of the retracting movement of the fingers through the loop, thus forming the bow of the knot as shown in Fig. 6.

Fig. 7. The Knot Completed.

The inventor found that one finger could have a purely rotary movement, as if it were fixed on the arm and unable to move independently of the arm, and the movement being as if the arm rotated like a shaft, but the second finger must be further capable of moving toward and from the first finger to perform the opening movement of Fig. 3, and the closing

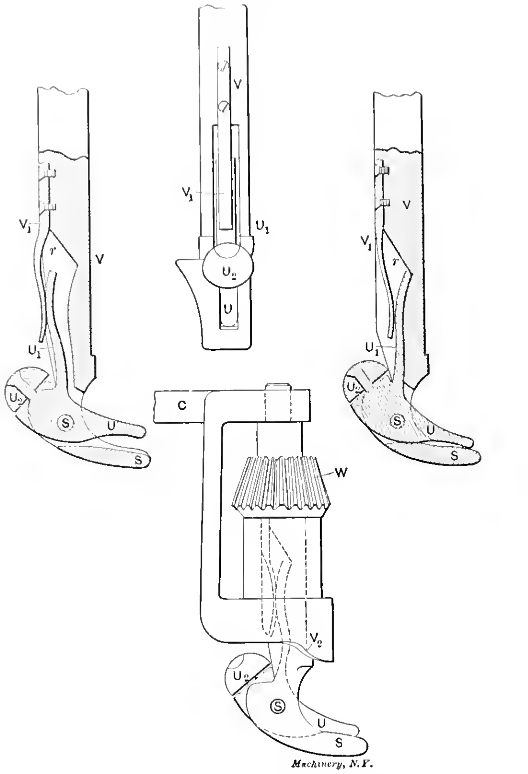


Fig. 8. The Essential Parts of the Cord Knotter.

movement of Fig. 4 by which it grasps the cord. The inventor accordingly, from his exhaustive analysis of his problem, and his invention or discovery of the proper finger motions, had further only to devise the very simple mechanical device illustrated in Fig. 8 to replace his fingers.

The index finger of the hand is represented by the finger *S*, which is integral with the shaft *V*. The second finger of the hand is represented by the finger *U*, which is pivoted to the first finger by the pin *S*. The grasping movement of the finger *U* is accomplished by a spring V_1 bearing on the shank U_1, and its opening movement is caused by the travel of an anti-friction roll U_2, on the rear end of the pivoted finger, over a cam V_2, on the bearing of the shaft. The shaft is rotated by the turning of a bevel pinion *W* on the shaft through the action of an intermittent gear. The necessity of drawing the fingers backward to accomplish the movement between Figs. 4 and 6 was avoided by causing the tied bundle to have a motion away from the fingers as it is expelled from the machine, the relative motion between the fingers and the knot being the same as if the fingers drew back.

Thus the accomplishment of a seemingly almost impossible function was rendered mechanically simple by an evolution from the human hand, after an exhaustive and ingenious analysis of the conditions involved.

ALCOHOL AS A FUEL FOR GAS ENGINES.

Abstract of article by H. Diedrichs, in "International Marine Engineering," July, 1906.

Ethyl alcohol, whose chemical formula is C_2H_6O, may be made in various ways, but the commercial alcohol of to-day is the result of fermentation, generally of grape sugar, in the final stage. The raw materials are various; they may be divided into three classes:

1. Those containing starch, *e. g.*, potatoes, with 15 to 24 per cent starch; rye, with 50 to 56 per cent starch; corn, with 60 per cent starch.
2. Those containing sugar, *e. g.*, sugar beet, with 8 to 18 per cent sugar; sugar cane, with 12 to 16 per cent sugar.
3. Those containing alcohol, *e. g.*, wine with 9 to 16 per cent alcohol.

The method of manufacture, of course, varies with the raw material, but need not be described in detail here. Theoretically, 100 pounds of grape sugar should yield 51 pounds of pure alcohol; in reality the yield is from 1-5 to 1-3 less than this amount.

The heating value of alcohol can not be accurately computed from its chemical composition, because nothing definite is known of the arrangement of the atoms entering the composition. We therefore have to depend upon the calorimeter. The figures determined for absolute alcohol by various experimenters are as follows:

	Higher Heating Value per pound.	Lower Heating Value per pound.
Thompson	13310 B. T. U.	12036 B. T. U.
Favre & Silberman	12913 B. T. U.	11664 B. T. U.

The value 11664 B. T. U. is the one most generally used. Absolute alcohol has a specific gravity of 0.7946 at 59 degrees F., so that one gallon of pure alcohol weighs 6.625 pounds, and has a lower heating value of 77,274 B. T. U.

One pound of C_2H_6O contains 0.522 pound carbon, 0.130 pound hydrogen, and 0.348 pound oxygen.

According to this, there will be required for the combustion of one pound of absolute or 100 per cent alcohol

$$\frac{(0.522 \times 2.66) + (0.130 \times 8) - 0.348}{0.23} = 9 \text{ pounds of air.}$$

This is the equivalent of 111.5 cubic feet of air at 62 degrees F. per pound of C_2H_6O. Commercial alcohol is never pure, but contains a certain quantity of water, the admixture being measured according to volume per cent. Thus, 90-per cent alcohol means that the mixture carries 10 per cent by volume of water. The heating value of such alcohol is correspondingly reduced from that of 100-per cent alcohol according to the following table, due to Schöttler:

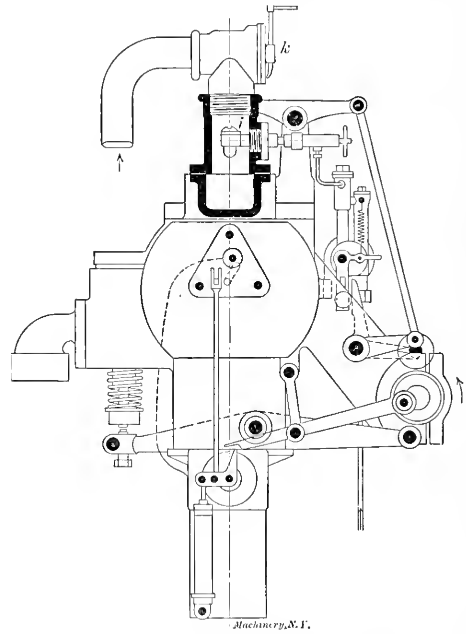


Fig. 1. Valve Mechanism of the Deutz Engine.

Absolute Alcohol Volume, per cent.	Specific Gravity.	Absolute Alcohol weight, per cent.	Lower Heating Value per pound. B. T. U.
95	0.805	93.8	10880
90	0.815	87.7	10080
85	0.826	81.8	9360
80	0.836	76.1	8630
75	0.846	70.5	7920
70	0.856	65.0	7200

It is required by law, in countries where alcohol is now used

in the industries, to so fix the fuel that it is rendered undrinkable. This process is called "denaturizing" alcohol. Several different materials are used to denaturize ethyl alcohol; wood alcohol, benzine, and benzol being the most common.

There is a second reason why benzol is used. Under certain conditions acetic acid is formed as a product of combustion of alcohol, and this causes rusting of the engine parts. This action takes place only when there is an insufficient supply of air, and the surest way to prevent rusting is to have

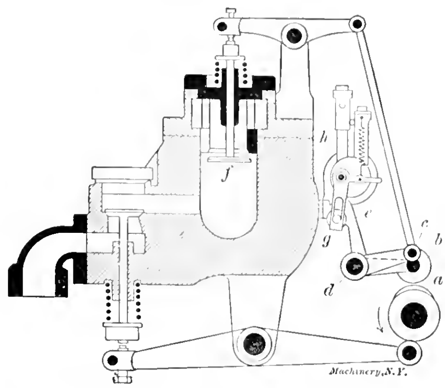


Fig. 2. Section through Valves of the Deutz Engine.

an excess of air and a perfect mixture of the alcohol vapor with it; but it is a good safeguard to use benzol, as it prevents the oxidizing action. There is one objection to its use, however, and that is that it destroys the odorless quality of the exhaust of pure alcohol.

The engines used with alcohol do not differ materially from the ordinary gasoline machine. As a matter of fact, any gasoline or gas engine can be run with alcohol if only proper means be provided to form the fuel mixture. The first trials with alcohol were made on liquid fuel engines. It was soon discovered, however, that the efficiency of operation could be materially increased if the compression were increased above

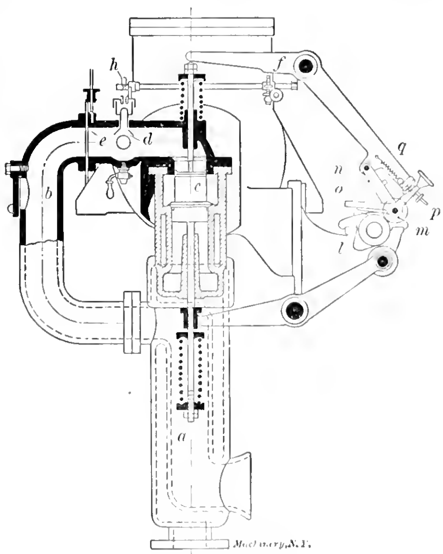


Fig 3. The Altman Vaporizer.

that possible for gasoline. Hence this is the main point of difference between gasoline and alcohol engines. The other point is one above mentioned, *i. e.*, that a different carbureter or vaporizer is required.

Very little has been done in this country with alcohol engines. Therefore, we have to look to Europe, especially to Germany and France, for information on this subject.

Regarding the fuel mixture with alcohol, it is less volatile than gasoline, but easier to handle than kerosene. In nearly all the vaporizing devices for alcohol, the agency of heat, usually the exhaust heat of the waste gases, is used to aid in the formation of the mixture. This scheme has the drawback that no heat is available at the start when the engine is cold, and it is next to impossible to start a cold engine on alcohol. To avoid an open flame, to start the engine, which is dangerous and cumbersome, the engine is started in most cases with gasoline, and after a few strokes, by throwing a lever, it is changed over to alcohol. The time required to heat up the parts of the engine sufficiently to change over to alcohol varies from about one to six minutes.

Based on the manner of heating, vaporizers are divided into three classes as follows: 1. Those in which no heat is employed. 2. Those in which the air is preheated. 3. Those in which the mixture is heated and superheated.

Of the first type is the Deutz, Figs. 1 and 2. When the engine is regulated by the throttling method, and not by the hit-and-miss system, it has been found that no preheating of air or fuel is required. The reason for this is, undoubtedly, that in a hit-and-miss engine, under less than normal load, a succession of misses cools the cylinder so far as to throw down some of the alcohol vapor on the next explosion, unless it is superheated. The Deutz engine is governed by throttling. The inlet valve, *f*, is actuated through the levers shown, by the cam, *a*, which is of taper form and under the control of the governor. Upon the position of *a* depends the length of time the valve, *f*, is open. Through the bell crank, *c d e*, the cam also acts upon the plunger of the fuel pump, *h*, operating in such a way as to cause suction during the first part of the cam movement and pumping of the liquid during

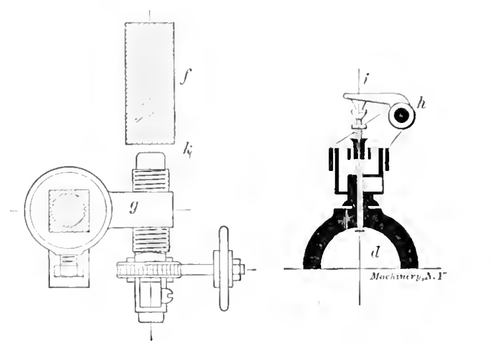


Fig. 4. Charge Regulator and, Fig. 5, Fuel Valves of the Altman Engine.

the second. Thus the fuel is injected during the second half of the suction stroke only, insuring a rich mixture around the igniter. The alcohol is forced through the sprayer or atomizer, *i*, Fig. 1, into the current of air which enters through the valve, *k*. Thus no preheating whatever is done, but the atomizing is thorough; and the ports into the cylinder are as direct and short as possible, hence no vapor is thrown down.

The Altman vaporizer, Fig. 3, is of the second class. The air pipe *a—b* is surrounded at its lower end by the exhaust pipe; the air is thus preheated by the exhaust gases. A regulating valve for the air is placed at *e*. This, when drawn upward, decreases the amount of air passing, but always makes the air current strike through the upper part of the pipe, in this manner directing it always against the fuel nozzle, *d*. The inlet valve, *c*, is operated by the lever, *f*, actuated by the cam, *l*, through the pendulum hit-and-miss governor, *o m p*. This valve lever, *f*, at the same time opens the fuel valve, *d*, through the reach rod shown and the finger, *h i*, Fig. 5. How this is done is shown in Fig. 4. The lever, *f*, on being depressed, forces down the point of the screw, *k*, thereby turning the reach rod about its axis, which depresses the point, *i*, Fig. 5, opening the valve *d*. The amount of opening depends upon the position of the screw, *k*, and this can be very finely adjusted by the worm and wheel arrangement shown. In this vaporizer the fuel supply is atomized partly by the current of air, and is afterward vaporized by the heat of the preheated air.

The following three vaporizers are of the third class. Fig. 6 shows the Swiderski-Longuemarre. Here also the exhaust gases are used for heating. They pass through the annular

chamber, a, and their action is aided by the radiating webs. $b—b$. The float, d, maintains a constant level in the supply chamber. From this chamber the flow of alcohol is regulated by the needle valve, f. The liquid flows into the space g, and overflows through a number of small openings, $h—h$. Air entering through i is made to pass partly outside, partly inside the concentric spaces created by the sleeves k. The amount of air passing outside is regulated by the openings $n—n$, which are controlled by the lever l. The air currents passing upward carry along with them some of the liquid, the

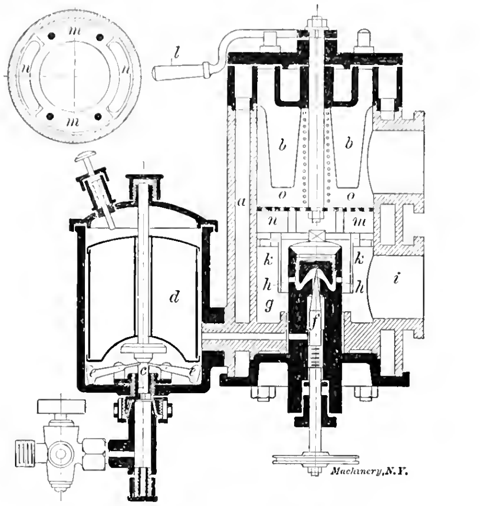


Fig. 6. The Swiderski-Longuemarre Vaporizer.

mixture being heated by the exhaust gases in a. The perforated plate, o, tends to aid in forming a uniform mixture.

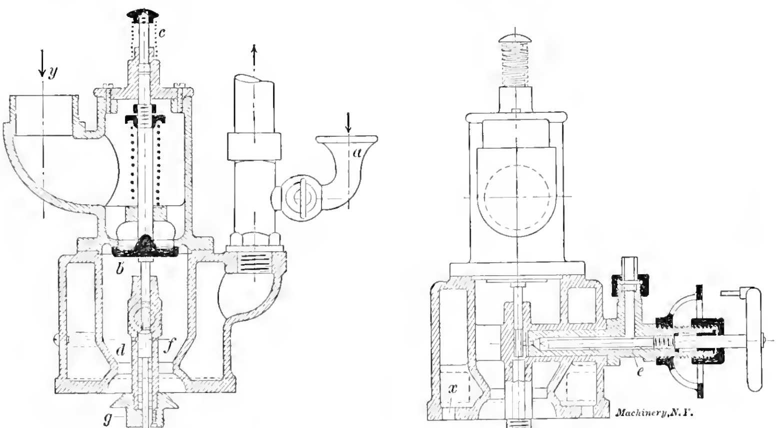
The vaporizer of the Dresdener Gåsmotorenfabrik is shown in Figs. 7 and 8. The warm cooling water of the engine is used for heating. It enters the water space at x. Air enters at y. The inlet valve, b, is automatic. It may be pushed down at will at the start by pressing down on the projecting stem, c. The downward movement of the inlet valve opens the fuel valve, d, to which alcohol is furnished through the needle valve, e, Fig. 8. Through a number of fine openings means of baffle plates are made to take the course shown by the arrows, through the space f. Further, the space e is filled with a large number of metal spirals, which connect the outside wall of e with its inside wall, thus furnishing a large heated surface to the passage of the charge, and facilitating the transfer of heat from the space f to the space d.

Finally, Fig. 10 shows what may be called a double float carbureter, which is the form that alcohol vaporizers are likely to take. This is used on the Marienfelde machines. Assume that the chamber a is used for gasoline, b for alcohol. The needle supply valves can be held closed by the springs c and d, as shown.

On starting with gasoline, the chamber a is used. Spring c is pushed aside so that fuel can enter, being kept at constant level by the float. The valve, g, is so set that the path is open for the air from h past the gasoline nozzle, e, through g into the cylinder. At every suction stroke the inrushing air is then charged with gasoline issuing in a small jet from e. If it is desired to change to alcohol, spring c is pushed into place, spring d is pushed aside, and valve g is thrown over into the position shown Fig. 10, all the work of a moment. The air supply to this vaporizer is preheated.

It is quite evident from an examination of the vaporizer above described that the final temperature of the mixture is different in the different devices. Upon this temperature, however, depends in a great measure the only other point of difference between gasoline and alcohol engines, i.e., the amount of compression. All other things being the same, that fuel mixture entering the cylinder at the highest temperature will soonest give rise to preignition, under an increase in compression. High temperature of charge also affects engine capacity unfavorably. It therefore becomes important to determine approximately the *lowest* practical temperature of vaporization, and the heat necessary.

The amount of heat required depends upon the amount of alcohol (and its purity) per pound or cubic foot of air. Assuming that 90-volume-per-cent alcohol is used, the theoretical amount of air required for perfect combustion is 7.8 pounds. Assuming an excess of 50 per cent, which is a desir-



Figs. 7 and 8. Vaporizer made by the Dresdener Gasmotorenfabrik.

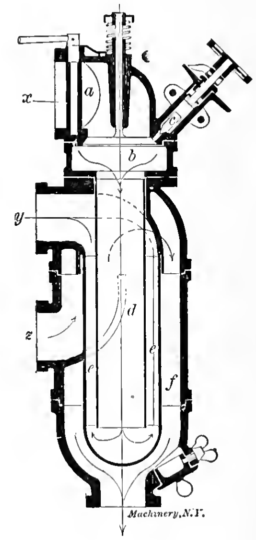


Fig. 9. The Durr Vaporizer.

the fuel flows into the current of air and is carried along with it, the thorough mixing being assisted by the current striking the cone g.

In contradistinction to the Dresden vaporizer, the Durr, Fig. 9, produces a highly heated mixture. The air enters at x and its amount is regulated by the throttle valve, a. The inlet valve, b, is automatic. Alcohol is supplied through the needle valve, c, as shown, so that when b is closed no flow of alcohol takes place. The current of air charged with alcohol particles passes down through d, up the annular space, e, and out at y to the cylinder. The exhaust gases enter at z, and by able allowance, 1 pound of 90 per cent alcohol would require in round numbers, 11.7 pounds of air. With the air temperature at 60 degrees F., and the atmospheric pressure, this amounts to 0.0065 pound of 90 per cent alcohol per foot of dry air. Ninety per cent (volume) alcohol is equivalent to 87.7 (weight) per cent, so that one pound of air will carry, according to the above assumed ratio of mixture, 0.075 pound of absolute alcohol, and 0.010 pound of water.

To compute the air temperature required so that it may take up the above quantities of alcohol and water vapor, we must know the relation between the temperature and the

degree of saturation. This relation is given in the following table:

Temp. degs. F.	Vapor Tension inches Mercury. Alcohol Vapor.	Water Vapor.	1 pound of Air contains in Saturated Condition, in pounds At 28.95 inches. Alcohol Vapor.	Water Vapor.	At 26.05 inches. Alcohol Vapor.	Water Vapor
50	0.950	0.359	0.055	0.008	0.061	0.009
59	1.283	0.500	0.075	0.011	0.084	0.013
68	1.733	0.687	0.101	0.016	0.117	0.018
77	2.325	0.925	0.144	0.022	0.162	0.025
86	3.090	1.240	0.200	0.031	0.227	0.036
104	5.270	2.162	0.390	0.063	0.450	0.072
122	8.660	3.620	0.827	0.135	1.002	0.164

Assume that the air is at a temperature of 59 degrees and just saturated. At a pressure of 26.05 inches of mercury this would correspond to 0.013 pound of water per pound of air in its initial condition. Now, in the case of the average mixture above computed, the temperature must be high enough to vaporize an additional 0.010 pound of water, making the total 0.023 pound that the air must contain per pound. It is seen from the table that a temperature of 77 degrees is quite sufficient to do this. It is also seen that at this temperature the air may take up 0.162 pound of absolute alcohol, while the quantity in the above mixture is only 0.075 pound per pound of mixture. At a temperature of 77 degrees the mixture ready for the cylinder may therefore contain the alcohol vapor in a state of some superheat. If the temperature of the walls with which the mixture comes in contact is not less than 77 degrees, no fear of condensation of alcohol vapor need be entertained.

The heat required to convert the liquid alcohol into vapor for temperatures above 32 degrees F., according to Regnault, is as follows: At 32 degrees F., 425.7 B. T. U. per pound; at 68 degrees F., 453.6 B. T. U. per pound; at 122 degrees F., 475.2 B. T. U. per pound; at 212 degrees F., 481.1 B. T. U. per pound.

The specific heat of liquid alcohol is close to 0.6, so that in order to convert the quantity of 90 volume per cent alcohol contained in the assumed mixture, to alcohol vapor at 77 degrees F., would require, approximately, assuming the liquid alcohol at 60 degrees F., 44.1 B. T. U. Now, the heating value of 90 volume per cent alcohol has been shown to be 10,080 B. T. U. per pound, so that the heating value of one pound of the assumed mixture will be $0.075 \times 10{,}080 = 756$ B. T. U. The heat of vaporization required, therefore, is $44.1 \div 756 =$

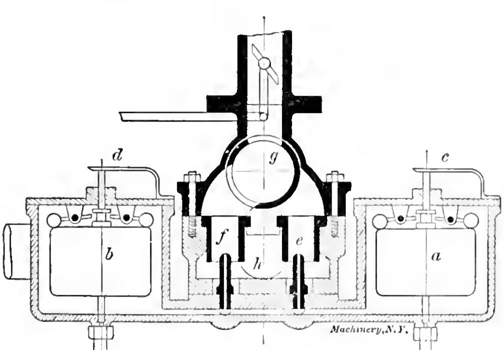


Fig. 10. The Marienfelde Double-float Carbureter.

5.8 per cent of the heating value of the fuel. It can be shown that this amount of heat is easily obtained from the exhaust gases.

If, on the other hand, the mixture and not the air is heated, then the walls need have a temperature only sufficiently higher than 77 to transfer the required amount of heat for vaporization to the mixture in the time available.

It is not desirable to impart a high temperature to the mixture, because then it cannot be compressed to as high a point, and, therefore, the efficiency will be lower. The best results are obtained in practice with a compression pressure of about 180 pounds, which gives a maximum explosion pressure of about 450 pounds.

The design of alcohol engines does not differ much from that of gasoline machines. Fig. 11 shows a two-cylinder launch engine built by Marienfelde. Alcohol is contained in the vessel *a*, which is filled through a strainer, *b*. The tank *a* is kept under a certain definite pressure by means of the exhaust gases, which force the alcohol into the left-hand float chamber of the vaporizer. Part of the exhaust gases pass through the strainer *f*, the check valve *h*, and the pipe *e*, to the fuel tank. *g* is a safety valve, so that by means of this, and the check valve *h*, a constant pressure is maintained on the liquid in the tank. The inlet valve, *i*, is automatic, while exhaust valve *k* is mechanically operated. The fresh air passes through a heater surrounding the exhaust pipe and is thus preheated on its way to the vaporizer. Ignition is pro-

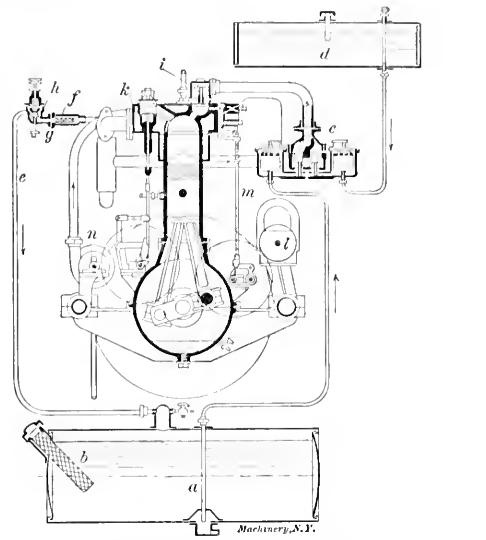


Fig. 11. Two-cylinder Marienfelde Launch Engine.

duced by the electro-magnetic apparatus *l*, *m* being the make-and-break gear. Regulation is effected by the hit-and-miss system. *n* is a small rotary pump to furnish circulating water for the jacket. The supply of gasoline required to start the machine is kept in a tank *d*, at higher level, so that the fuel is supplied to the right-hand float chamber by gravity. The operation of the vaporizer was explained under Fig. 10.

The following table of dimensions of Marienfelde engines gives some idea of the size of the machines:

Maximum Brake Horse-power.	R. P. M.	Cylinder Diameter, Inches.	Stroke, Inches.
8.0	220	6.70	11.80
13.2	220	7.90	14.20
21.0	202	9.85	15.75
24.5	200	11.00	15.75
30.0	200	13.80	15.75

As to the cost of operating alcohol engines it does not appear that they are likely to compete with gasoline unless the price of alcohol is made much lower than at present seems probable. The efficiency of gasoline engines can be estimated at 23 per cent as a maximum. The efficiency of alcohol engines is given at about 31 per cent. If gasoline and alcohol are taken at 15 cents per gallon, the cost of 1,000 B. T. U. for gasoline will be 1.35 cents, and for alcohol it will be 2.19 cents, owing to the fact that the heating value of the former is higher, the actual figures being as follows:

Gasoline, B. T. U. per pound.............. 19,000
Alcohol, B. T. U. per pound................. 10,080

It is seen at once that alcohol is saddled at the outset with a very serious handicap in the way of greater specific heat cost, as compared with either gasoline or kerosene. To be on a par, therefore, regarding cost of operation, the thermal efficiency of the alcohol engine would have to be $\frac{2.19}{1.35} = 1.62$ times greater than that of gasoline, and $\frac{2.19}{1.02} = 2.15$ times greater than that of kerosene, everything else in the way of engine losses being the same.

W. B., Jr.

PICKLING CASTINGS.

A writer in *Obermayer's Bulletin* says that from the machine shop workmen's standpoint there is a decided difference between castings which have been pickled and those which have not. No establishment that has used thoroughly pickled castings will be likely to be satisfied without pickling. Tumbling is not a substitute for pickling, as it does little toward removing the scale, but tumbling before pickling is good, as it saves the pickle. Pickling without tumbling is better than tumbling without pickling, so far as the wear of the tools is concerned. The wear of tools and the time required for resharpening and resetting is much greater when used on sandy and scaly castings than on those which have been thoroughly pickled. When this fact is thoroughly appreciated and the time-saving effected by pickling is known, the cost of the process cuts a small figure.

There are two somewhat different processes employed for pickling castings. For one process a lead-lined wooden tank is provided of size and shape determined by the size, shape and quantity of castings to be handled. With a tank 6 feet long, 3 feet wide and 2 feet deep, a large quantity of castings can be pickled. This tank should preferably be sunk a foot or so in the ground and from one of the long sides a tight wooden platform, say 6 feet wide and 12 feet long with raised strips on the edges, should extend back. The platform should have a pitch of two or three inches to the foot toward the tank.

The pickle should be made 1 part vitriol to 4 parts water. It is a common mistake to think that more vitriol will hurry matters and do the work more thoroughly, for the reverse is the case, as an excess of vitriol retards the action and therefore should be avoided. In preparing the pickle the water is put in first and the vitriol is added gradually, during which process the water heats up. Fill the tank to within 6 or 4 inches of the top. The articles to be pickled, if of convenient size to handle, are simply dipped in the pickle, so that they are wet all over, and then laid on the platform to drain and dry. If the castings are too large or too heavy for dipping, they are laid on the platform and the pickle is then poured over them with a dipper. They should be turned as much as necessary to wet them all over, and none of the castings should be left so that the pickle has a chance to settle in pockets or places that will not drain. The castings are then left for eight or twelve hours, when they will be covered with a white powdery substance. It is only necessary to dip the castings in boiling hot water, or to pour the hot water over them until they are thoroughly cleansed of the acid, and when they are dry, the process is completed. A hot water tank is, of course, provided, with a steam pipe for heating the water. This water should be renewed frequently so the acid will be thoroughly removed. An additional refinement is to provide a hot potash or soda bath before the final rinsing in clean water.

To pickle by the second process, tanks are provided of sufficient capacity to submerge the castings for several hours; sometimes they may remain in the pickle over night. When taken out they should be rinsed at once in an adjoining tank of clear water, or better, in two tanks in succession. The pickle for this slow process should be much weaker than for the first process described, the proportion of vitriol to water being about as 1 to 10.

* * *

CALCULATING CENTRIFUGAL FORCE.

W. H. ACKER.

"Centrifugal force," as it is somewhat vaguely called, is not really a force residing in the revolving body and tending to urge it away from the center; it is rather the extraneous force which has to be exerted to restrain the body in its circular path, and prevent it from following the tangent direction which it constantly tries to take in accordance with Newton's law that a moving body will continuously follow a straight line, unless acted on by some outside force. This restraining force is directly proportional to the radius of the circle described by the center of gravity or center of mass of the revolving body, its weight (or more strictly, its mass), and the square of the number of revolutions per minute. It may be calculated by the formula:

$$F = 0.000341\ W\ R\ n^2$$

in which

F = centrifugal force, in pounds,

W = weight of the revolving body in pounds,

R = radius of circular path described by the center of mass of the revolving body in feet,

n = number of revolutions per minute.

The accompanying diagrams (see Supplement) were prepared to give directly without calculations the centrifugal force of one pound for various radii and revolutions per minute. The way in which they are used will be readily understood. From the graduations at the left the horizontal line corresponding to the given radius, in feet or inches, is located. This line is followed toward the right until it intersects the diagonal line which corresponds with the required number of revolutions per minute. From this point of intersection a vertical line is dropped to the base margin, where the centrifugal force is directly read in pounds. This result, multiplied by the weight of the body, will give the required force for the case in hand.

It will be observed that the diagonals for the rate of revolution are terminated by a curve at the points where the intersections give a velocity of 5,000 feet per minute. This velocity is about the limit for cast-iron flywheel rims and similar parts, whose strength can be shown to be a function of the velocity and the physical properties of the material only. For speeds greater than this, each individual case should be calculated from data giving exact information on every point required.

As a simple case, suppose it is required to find the centrifugal force in the rim of a flywheel used on a gas engine. The rim of the flywheel weighs 500 pounds, the mean radius is 3 feet and the speed is 350 R. P. M. Referring to the curves (see Supplement) we find the centrifugal force per pound at 3 feet radius and 350 R. P. M. to be 126. Hence the centrifugal force in the rim is $126 \times 500 = 63{,}000$ pounds. This force is resisted by the two sections of the rim at the extremities of a diameter. A suitable factor of safety having been applied, we readily obtain the sectional area of rim necessary, knowing the tensile strength of material used.

Supposing it is required to find the centrifugal force exerted by the knife of a wood planer, the knife weighing 28 pounds, its center of mass being at a radius of 5 inches, and running at a speed of 1,800 R. P. M. From the curve sheets we get the centrifugal force per pound to be 460, at 5 inches radius and 1,800 R. P. M., and the total centrifugal force is $28 \times 460 =$ 12,880 pounds. Hence the tap bolts holding the knives in place must be of sufficient size to overcome this force, allowing a suitable factor of safety.

Supposing it is required to find the centrifugal force exerted by a field coil on a revolving field generator. Weight of coil 42 pounds, R. P. M. 100, and radius to center of mass of coil 10 feet. From the tables we obtain a value of 34 for the centrifugal force per pound, and the total centrifugal force is $34 \times 42 = 1{,}428$ pounds.

The values as obtained from the curve sheets will be sufficiently accurate for all computations of this kind, as in all cases a large factor of safety is employed in proportioning parts to withstand the strain.

* * *

The Japanese Government has recently made considerable changes in its tariff rates, largely necessitated by the cost of their recent war. It is evident, however, from examination of the schedule, that the duties of the various articles of commerce have been arranged with the idea, not only of yielding a sufficient revenue, but of protecting, as well, such Japanese industries as seem capable of development. Locomotives and tenders are charged 20 per cent *ad valorem*; the rate of boilers, steam engines, textile machinery, electrical machinery, machine tools, etc., is 15 per cent *ad valorem*. A number of manufactured articles in which the Japanese have attained considerable efficiency have been put in the high duty class. Watches, spectacles, photographic apparatus, etc., are charged as high as 40 or 50 per cent.

A COUNTRY MACHINE SHOP.

R. E. F.

With my ears singing from the rattle of heavy trucks on the paving stones and the rumble of the elevated trains that grind past the windows of our shop, I read the "Wail from New Jersey," which Mr. Press contributed to the June issue. The pathos and poetry of the appeal from the machinist over across the North River struck a responsive note in my breast, and as soon as my yearly vacation week came around I hiked back for a look at the country shop where I worked before the fascinations of the metropolis lured me away. The shop is still there, all right, with the surrounding trees and the mill pond and dam. The plant seems to have spread out some,

Fig. 1. The Shop from across the Mill Pond.

however, and there are nearly twice as many men as there used to be when I worked there, which was not so very long ago, after all.

We had lots of fun getting this shop going. Originally there were only two of us, the proprietor and myself. He had worked out a scheme for an automatic machine for making paper boxes, and I was trying to help out a bit on the design, and the equipment of a little shop to make them in. After the drawings and the experimental machine had developed to a point where we felt safe about them, the boss and myself put on our coats one afternoon and started out shop hunting. The town was not a very large one, so the available locations were not so many as to confuse us in this enterprise. The situation that took our eyes was the one where was located the shop shown in Fig. 1. It had originally been the weaving department of a cotton mill of which the other buildings were located a considerable distance down stream. It was run by water power from a brook fed by a storage reservoir of sufficient capacity to insure us a supply of water in any ordinary dry season. The buildings were in pretty poor shape, having been out of use for a dozen years, so when the arrangements which gave us the control of the property were finally made, there was plenty of work to do before the place was in fit condition to use.

After getting a number of men at work covering the roof, leveling up the floors, and glazing the window frames, we started to investigate the condition of the water wheel which had lain so long submerged without attention or repair. "Henry," a "down-east" combination millwright, toolmaker, carpenter and blacksmith, who had cast in his lot with ours, undertook this investigation with great enthusiasm. The manhole of the waterwheel casing was pretty slim, but Henry, like most of his race, was still slimmer. So, after getting him into a pair of hip boots, we opened the cover and he wriggled through the opening and disappeared. Not for long, however. Sputtering and gasping, he soon came in sight again and explained that he had been unable to find the bottom and had concluded to come to the surface for further deliberation.

It was evidently necessary to lower the level of the water below the wheel before we would be able to clean out the accumulated rust and mud from inside the casing. The water at the foot of the dam formed a mill pond for another power plant below us, so I set off downstream to interview the man in charge as to the possibility of lowering his pond a little to allow us to get at the wheel. The caretaker, however, was somewhat crusty and was unwilling to lower the level of his pond, fearing that he would not have power enough if he did so. After looking the plant over, it was evident that this fear was entirely groundless, as the wheel was only running at a small fraction of its capacity and the greater part of the stream was running over the dam. Argument failed to impress him, however; the owners of the place were in a distant city and difficult to reach, so we had to devise some way to regulate the height of this lower pond from our place up stream.

This seemed at first a rather difficult proposition, but it worked out very easily after all. We went home one night with the waste gate of the dam left open so as to drain the pond and stream above us. On my way to the shop the next morning, while still nearly a mile away, my nose was assailed with the odor of drying pond mud and exposed aquatic vegetation, so it was immediately evident that the pond had been drained. Hastily, and in momentary dread of a visit from the rural board of health, we closed the gate again, thus allowing the pond to fill up, taking the opportunity meanwhile to examine and repair the rack at the entrance of the penstock.

Of course the great mass of the water which had come over during the night had gone over our lower neighbor's dam. When the gate was closed again he had no greater supply on hand than usual, so his wheel had to use what little was left in the small pond below us. This was in this way drained out gradually, until it was lowered to a point which permitted full examination of the interior of our wheel; then enough water was allowed to flow through the gate to keep the level constant at this point, thus assuring our neighbor of a sufficient supply of water. This was a rather arbitrary proceeding, and might have caused trouble for mills lower down which were running at their full capacity, but circumstances were such that we could serve ourselves in this way without injuring any one else.

Besides being filled with mud, the water wheel was found to need repairs. Two short racks which meshed with pinions

Fig. 2. The Cool Outlook from the Tool Room Window.

on the gate wheel shaft and were used for raising and lowering the circular gate, had rusted away so that only the first few teeth were intact. For this reason it was impossible to raise the gate more than about one-quarter of its proper height. An order was given to the makers of the wheel for such repair parts as were necessary for this job, and these were put in place. Although the wheel was nearly twenty years old the position of the drilled holes, and the fits in general were so nearly correct that we had a very high idea of the management of the shop that furnished the wheel and the repair parts.

One of the interesting things about this old shop was the line of shafting which had been used to drive the looms when it was run as a weaving shed. This shaft was located beneath the floor the whole length of the shop, and its sections were

coupled together with screwed joints in about the same way that steam pipe is fitted up, except that there were no left-hand threads and no unions. The arrangement of the masonry and the supporting structure was such that this shaft had to be assembled or disassembled from one end. How in the world the mechanic who fitted that place up expected to remove or repair any one of the dozens of solid hangers or scores of solid pulleys on that length of shaft, it is hard to say. To replace a hanger or pulley on the center of the line, he would have to commence at one end, unscrew each coupling in turn with all its hangers and pulleys, and take the whole thing down until he came to the length of shaft containing the parts he wished to replace, reversing the operation to put the parts back in position again. We wanted to make use of a short length of this old line as an intermediate jackshaft between the water wheel and the main line on the ceiling of the shop above. After one or two attempts at unscrewing the old rusty couplings we gave up the job, and started the strongest and best-natured boy in our force on the task of severing this length of 3½-inch jackshaft from the rest of the line, with no tools but his muscle and a hacksaw frame with plenty of sharp blades. After this had been accomplished, the ends of the shafts were forced apart until there was no danger of rubbing, when the short length was put in commission.

The floor of the waterwheel pit was composed of heavy beams with only an occasional board. In the spring this room was a favorite place for the boys to soldier, especially when suckers were running. They would rig up any makeshift sort of a spear that came handy, sneak down the two flights of back stairs, and stand near an opening in the floor, ready to land a sucker or any other suitable fish that might happen to come within range. One of the men was quite expert in this occupation—expert, that is, not only in sticking the fish, but escaping the boss as well. One large pickerel that he captured he was especially proud of. To prevent its recapture by any of the other workmen, he fastened it in his locker. One of the boys, however, came into the office and prevailed upon the boss to let him have the duplicate key for a few moments, explaining his intentions meanwhile. He poked a cent piece as far down the fish's throat as he could reach with a long lead pencil, and returned the key. The fisherman had a great story to tell next morning about what his wife found when she opened up his catch.

It is something of a pleasure after all to work in a shop surrounded with green grass and elms and cedar trees, with a water-fall splashing away just outside the toolroom window. There is lots to interest one when he gets tired working. There are fishermen to watch over across on the other bank; one's friends and neighbors occasionally pass by the shop windows and on rare occasions drop in to see one. In winter, sometimes, when the air is just right, the foam at the foot of the falls freezes together into great round "cocoanut cakes," as we used to call them, twelve or eighteen inches in diameter and six inches thick, which swirl around in the open water below the dam and look good enough to eat. Later on, when the below zero weather comes, the falls, with the water below them as well, freeze over solid. Their roar is silenced, and one might almost imagine that the whole stream was congealed clear to the bottom, were it not for the fact that the wheel is still working away and the pulleys are going around as fast as ever. The hours are on the whole a little longer in this country shop, but no one seems to mind that particularly. There are not so many workmen as there are in the big shop in the city, but being fewer they have more interest in the work they are doing. Each man knows all about the whole product of the plant, and is personally interested in this new attachment and that special machine and the order which has to be gotten out day after to-morrow; and so no one objects much to hustling a little and working overtime when it is necessary. Take it all together, the memory of this New Hampshire shop seems to come back to me quite strongly as the springtime of each year returns.

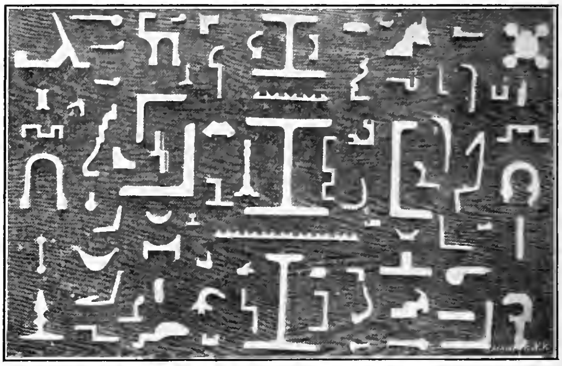
* * *

Large four-cycle gas engines using producer gas may be safely estimated to develop one brake horse-power per hour on one pound of coal; or tersely put: 1 pound, 1 B.H.P., 1 hour.

EXTRUDED METAL SECTIONS.

One of the interesting exhibits at Atlantic City, N. J., on the occasion of the recent Master Mechanics' and Master Car Builders' Associations conventions, was that of the Coe Brass Mfg. Co., Torrington, Conn., showing a number of extruded brass and bronze metal sections, and of billets partially extruded. The accompanying cut shows a few of these sections fastened to an exhibit board. In view of the extensive use that can be made of these sections, a short description of the process and the metal will not be without interest.

The process of making metal shapes by extrusion is similar to that of forming lead pipe, but is, of course, attended by considerably more difficulty, inasmuch as the alloys of brass and bronze have to be heated to a comparatively high working temperature, whereas lead may be extruded cold. The process was developed abroad, being invented, we believe, by Mr. Alexander Dick of London about twelve or fourteen years ago. By the process of extrusion bars or rods of almost any required cross section may be produced in brass or high tensile strength bronze and so accurately that no machining is afterward required. The process consists of squeezing the heated metal through dies to the required shape by hydraulic pressure (oftentimes as high as 60,000 pounds per square inch). The very high compression to which the semi-plastic material is subjected renders it homogeneous and free from ordinary casting defects. The dimensions of the finished bars are limited by the weight of the billets used, these ranging in weight from 150 to 175 pounds. At the present time the company are to produce at their Ansonia, Conn., plant special shaped bars or rods ranging from light sections of about ⅜ inch diameter and weighing a fraction of a pound per foot to heavy sections 5 or 6 inches in width and weighing several pounds per foot. The length in which these sections can be obtained depends upon the size, it being obvious that the heavy sections must be produced in shorter total lengths than the light sections.



Examples of Extruded Sections.

The word extrusion accurately describes the operation by which various sections are formed. Billets of brass or bronze are formed of cylinders of about 7 inches diameter, and these are heated until of a plastic consistency and then by means of a small crane are placed within a strong horizontal cylinder or container at the front end of which is a die. Upon hydraulic pressure being applied at the rear end of the condenser the plastic metal is forced or squirted through the die, issuing therefrom in a long bar having a cross section corresponding to the hole pierced in the die. Mr. Dick was a long time perfecting the process owing to the difficulty of obtaining suitable material for the construction of the container, die, etc. All these parts have to withstand without yielding a pressure of 25 or 30 tons to a square inch when practically red-hot. The machine consists essentially of a hydraulic press of very massive construction, the principal parts being two crossheads, one holding the hydraulic cylinder and the other at the opposite end arranged for holding the die, the two being connected by two strong columns. Between these columns is the container for holding the billet of heated brass.

As regards the quality of metal produced by this process,

some tests made by the company on naval brass extruded rods for bolt stock showed that the material possessed an elastic limit of 41,600 pounds per square inch and a maximum strength of 63,200 pounds and an elongation of 21 per cent in a length of 8 inches. The reduction in area was 19.4 per cent.

A considerable use that has been found for this metal is in the form of moldings for architectural work. It is well adapted for use in large stores and office buildings, railroad stations, residences, etc., and can be oxidized to give it any color desired. Extruded moldings are also supplied for use in the construction of passenger and sleeping cars, as the metal will take a high finish, is durable, and does not rust out or corrode in service. It is also largely used for step treads, step nosings, platform binding, hinges and door stops, having taken the place of brass castings for these purposes. In fact, extruded shapes made in a free drilling and free milling stock, have superseded castings for many purposes. The metal being perfectly smooth and accurate requires little, if any machining, and is utilized in a great variety of manufacturing lines, small pieces being sawed or milled from special shape extruded brass bars to take the place of machined castings. This affords an efficient and economical means of making small, intricate parts such as cams, dogs, pinion wheels, and various other parts that are required in the manufacture of locks, typewriters, steam turbine blades, telephone and telegraph instruments, switchboards, and other electrical apparatus.

* * *

WHAT THE POWER HACK SAW CAN DO.

Probably there is no other small machine tool ever put on the market that became popular so quickly as the power hack-saw. An illustration of what large jobs this small machine can do is shown in the accompanying cut, the photograph for which was made in the shop of certain customers of the Hoefer Mfg. Co., Freeport, Ill. It shows how one of the hack-saw machines made by the latter concern was adapted to cutting off the riser head of a steel casting for a heavy crankshaft. The regular lathes in the customers' shops being busy, they did not care to take the time or run the risk of cutting off the riser head in any one of them, so a saw frame

A Power Hack Saw Working up to its Limit.

was made for the machine which would take in an 18-inch blade. This frame was turned around end to end, as shown in the cut, and the machine was moved up to the steel forging and driven from the lineshaft. The shaft at the point the riser was cut off is $11\frac{1}{2}$ inches in diameter. It took twenty hours to saw it through, but as there was no particular hurry for the job the time required was not a matter for much consideration. The crankshaft and riser were separated by two cuts, being cut half way from one side and then turned over and cut through from the opposite side. Two saw blades were used up in the operation. The Hoefer Mfg. Co. inform us that no other power hack-saw of a similar type can be reversed and used in the manner shown in the cut.

SAMUEL WEBBER.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Samuel Webber was born in Charlestown, N. H., in 1823, and was carefully brought up by his father, a physician, in the outdoor life of a country boy, from a delicate child developing into a strong, vigorous man. He was taught to handle horses, cows, and pigs, to hoe corn, dig potatoes, and saw wood, to take all possible exercise in the open air and to fish and shoot every holiday, thus forming a constitution which has given him a long and busy life. Educated at home, mainly with the intention of a mercantile life, he studied French, Italian and Spanish, with sufficient Latin to ground him fairly in those languages, and with a mathematical taste, inherited from his father and grandfather, which, aided by the immediate proximity of a blacksmith's and wheelwright's shop, turned the current of his life to mechanics, and he accordingly, at the age of seventeen, left home for the city of Lowell, "to seek his fortune" in some of the manufacturing establishments then being constructed.

Here he was fortunate enough to be aided by the friendship of Dr. Samuel S. Dana, the chemist of the Merrimac Mfg. Co., who was then investigating the newly discovered process of electrotyping, and at once put to work on experiments to apply this process to the engraving of copper rollers for calico printing. All the electricity we then had was procured from galvanic batteries, and the young student soon became familiar with the handling of the Smee and other forms of voltaic batteries then in use, but the practical results of the experiments proved unsuccessful. The operation of etching the lines drawn by a diamond point on the surface of a copper roller covered with an asphaltum varnish, which was to be eaten out by the acid liberated by the electric current from a solution of sulphate of copper, proved too slow, and the varnish was destroyed before the lines were sunk deep enough. By reversing the current, it was possible to deposit figures on the surface of the rollers in such points as were protected by the varnish, but here came another difficulty: the deposited copper did not adhere strongly enough to the rollers to bear the mechanical strain to which they were subjected in the printing machines, and after long experimenting, the attempt was abandoned, to be followed by a return to the known method of etching with nitric acid. Here the lines cut by the diamond through the varnish were eaten to the required depth by the acid in a very few minutes, but the work of drawing the lines through the varnish was confined to such lines as could be drawn by a simple ruling machine or by such a machine as is used in drawing the eccentric work commonly used in bank note engraving, and could only be performed with a single diamond. At this time a new factor came into the situation. Milton D. Whipple, an ingenious mechanic and inventor, came to Lowell with a machine for removing the burrs from South

American wool, and learning that the Merrimac Co. were engaged in experiments on engraving, came to them with suggestions for a process of his own. He looked over the matter, proposed a plan for using a number of diamond points, instead of one, dismantled the old eccentric machine, and devised one which should use as many diamonds as the width of the design required to cover the roller, and produced a power-driven machine which answered all the purposes for engraving stripes, checks, and other rectilinear figures. He then turned his attention to a pantograph machine for engraving curved lines, and designs of that character, using as before a multiplicity of diamonds.

In all this Mr. Webber assisted him and derived much valuable information from Mr. Whipple's clear insight into mechanical principles and motions. They spent many months in these operations before succeeding in producing an evenly etched roller, but Mr. Whipple built a machine for grinding all the diamonds to a uniform cutting point. Mr. Webber discovered that the unequal density of the copper rollers was the cause of imperfect work, and cured it by burnishing the surfaces under heavy pressure, until the whole plan became a success and the etching process has been universally used in all the print works in the country.

These things accomplished, Mr. Whipple left Lowell for other inventions, and Mr. Webber, not content to engrave copper rollers as an occupation for life, also sought new fields and accepted an invitation from the late Horace Gray, of Boston, then largely engaged in iron manufacture on Lake Champlain, to investigate that subject in the summer of 1847. Mr. Gray explained the subject in practically these words: "The whole question of the successful manufacture of iron is contained in the letters of a single word—'Colt.' These letters stand for Coal, Ore, Labor, and Transportation, and whoever can master their meaning and catch that colt is assured of a fortune." He proposed that Mr. Webber study the matter theoretically for a short time, especially the chemistry of iron, then visit the works on Lake Champlain and other places in this country and Europe, and decide on the plans for more extensive works.

Mr. Gray's words and insight were prophetic, but his too-extended operations with deficient capital at Lake Champlain brought on his financial failure and stopped the whole project. Mr. Webber, who had spent a short time studying chemistry under Prof. Horsford at Cambridge, found himself entirely adrift, but having studied mechanical drawing in his evenings at Lowell, he soon secured a position as draftsman and assistant engineer at the Bay State mills, then being built at the new city of Lawrence. When the mills were completed, he became assistant superintendent and finally superintendent of them, employing at one time 1,700 operatives.

This mill, the Bay State, commenced operations in 1848, with the manufacture of tartan and other Scotch woolen shawls, and was for a time very successful, but Mr. Webber's health broke down with long labor added to two severe attacks of illness, and he was forced to give up business. He was advised by his physicians to take a sea voyage, and this was accomplished by receiving a commission from the treasurer of the Bay State Mills and the Essex Co. to visit the manufacturing districts of Europe, look into the worsted and linen mills, and see if either branch of manufacture could be profitably introduced into this country. He accordingly left New York in October, 1850, in the sailing packet *West Point*, and landed in Liverpool after an easy voyage of seventeen days.

The following winter and spring months were spent in visiting the mills of England, Scotland, France and Belgium, and examining their processes. He found the introduction of linen to be impracticable, for though the machinery was simple, the processes of preparing the flax for spinning required such an amount of tedious hand labor in retting and hackling the fiber as to render it useless to attempt this branch of manufacture.

With worsted the case was easier; the wool was available in any quantity in the United States and the machinery and its operations were simple. He accordingly purchased for the Essex Co. a complete set of worsted-spinning machinery, together with such other tools, machines and drawings as seemed to him worthy of introduction, among them the drawings of the "link motion" for locomotive engines, then new, and not in universal use. This business took him very well over Great Britain, and included a visit to the iron works at Cyfarthfa and Merthyr Tydvil, to examine the manner of making rails for American railroads. Through the influence of the Hon. Abbott Lawrence, then American minister to Great Britain, he was appointed one of the jurors for the great International Exposition in Hyde Park, then called the "Crystal Palace," in May, 1851, and here he served for three months in company with Gen. Poncelet, the celebrated French engineer, Professor Willis, of Cambridge, and other prominent engineers, examining "machinery and machine tools" and forming the acquaintance of such men as Whitworth, Fairbairn, Nasmyth, Rennie, Scott-Rupell, and other prominent engineers and mechanics. Here Mr. Webber found his early study of French of great value, as it enabled him to serve as an interpreter between the English and Continental judges, some of whom could not speak both languages, in the absence of Prof. Willis, who could.

Returning to Lawrence in the autumn of 1851, the next year was spent in setting up the worsted machinery which he had brought home, and developing its capacity for the intended purpose, but the Pacific Mills, for whose use it was proposed, had already extended their plant to the full employment of the capital, and the project was abandoned for the time being, though successfully carried out a few years later. In the meantime, Mr. Webber had been called to New York to take charge of the arrangements for the proposed exhibition at the so-called Crystal Palace, in the Reservoir Square, now Bryant Park, on 42d St. Here he remained through 1853, allotting the space, installing the exhibits, and finally acting as Commissioner of Juries.

In December, 1853, he went to Indian Orchard, in the city of Springfield, Mass., to take charge of an unfinished cotton mill, which had been abandoned for financial reasons. Here, on procuring fresh capital, he completed the mill, revised and changed the contracts for unfinished machinery, installed the waterwheel and shafting and put the mill in operation in 1854. The financial panic of 1857 caused a suspension of work there, and Mr. Webber was transferred to the position of manager of the Manchester Print Works, at Manchester, N. H. Here his previous experience in Lowell came in play to good advantage, and he remained for six years, resigning the position to take charge of the Portsmouth steam mill at Portsmouth, N. H. In 1861 the Civil War broke out, and Mr. Webber, having been appointed an aide-de-camp to Gov. Berry, of New Hampshire, was very busy for many months, in addition to his regular labors, in raising and looking after troops for the army. He organized and equipped the first New Hampshire battery of Light Artillery, acting under the permission of the Governor and Council, and in company with the Governor, escorted them to Washington in October, 1861. When the war closed in 1865, the enormous fall in prices of materials wrecked the Portsmouth mills, Sea Island cotton, of which they had a large stock, falling from $3 to 80 cents a pound, and Mr. Webber was thrown out of business. He spent some months in various engineering operations, among other things preparing plans for the water power at Bellows Falls, Vt., and in 1866 was appointed assistant appraiser of textile fabrics for the port of New York. Here he remained four years, until a political change in the administration threw the whole board of appraisers out, and he then went to Washington, where he remained some months, revising and correcting the returns of the Industrial Division of the census of 1870.

During Mr. Webber's six years' residence in Lowell, he formed the acquaintance of two prominent engineers, Messrs. Uriah A. Boyden and James B. Francis, and with Mr. Boyden watched the installation of the first Fourneyron turbine, in the mills of the Appleton Co. at Lowell. With Mr. Francis, the acquaintance grew into a lifelong friendship, and from Mr. Francis he received a great deal of valuable information, watching carefully his experiments on the flow and measurement of water, and the tests of power utilized by turbines, and consumed by other machinery. This stood him in good stead, when after his return from the Census Bureau he was invited by Mr. Straw, the agent of the Amoskeag Co., to examine and determine the amount of power actually consumed by

the mills in Manchester which had apparently exhausted their water supply. These measurements were made and resulted in a general reorganization of the Amoskeag power plant, the power consumed being found to be largely in excess of that conveyed by the deeds of water. This was followed by a long series of examinations and measurements in the different cotton and woollen mills in New England lasting several years, and including two sets of tests of the Geyelin-Jonval turbines, furnished for the Manchester water works, the first set having proved too small to supply the necessary power. In 1876 Mr. Webber was appointed one of the judges of the Centennial Exposition at Philadelphia and here he spent several months serving on different groups of judges, and finally conducting a series of tests of all the turbines exhibited, which were only completed on the day the exposition closed.

After this he continued his labors in the measurement of power until in 1879 at the request of Mr. Francis he published a small volume entitled "A Manual of Power" giving the result of his different observations of the tests of turbines and many hundred of measures of the power consumed in cotton and woolen mills with tables of the power required for shafting and belting, to which was later added one on gearing published in the Journal of the Franklin Institute. This "Manual of Power" was published under the auspices of the New England Cotton Manufacturers' Association, of which he was one of the founders in 1865 and of which he is now an honorary member. In 1880, at the invitation of Professors Sweet and Thurston, he met them with a dozen other engineers at the office of the *American Machinist* in New York and there founded the American Society of Mechanical Engineers, now containing two thousand members. To the transaction of this society he has at times contributed various papers and discussions. In the summer of 1880 he was appointed one of the judges of the cotton exposition at Atlanta and after attending to the duties of that post made practical tests of the power of various traction engines, the precursors of the modern automobile.

Returning to Manchester, he removed in 1883 to Lawrence, Mass., to advise with his sons in a machine shop which they had established there, and where he made the calculation and drawings for a portable dynamometer, which they constructed for him, and which has since been called by his name. About this time he went to Augusta, Ga., and tested the power for the turbines in the John P. King mill, it being the heaviest turbine test made up to that date, being nearly 500 horsepower.

In 1884 he was called to New Orleans, where he laid out the power plant for the New Orleans Exhibition, and arranged the engines, shafting and machinery exhibited. This occupied the summer and autumn, and in December he returned to New England by water, coming down the river to see the "Eads jetties" and round through the Gulf of Mexico. In the spring of 1885 he removed to his native town of Charlestown on account of his health, finding it very easy to reach by rail all the manufacturing centers of New England, as well as those of New York, New Jersey and Pennsylvania. From this point he continued his observations for nearly twenty years longer, his last active engineering work being the gaging of the summer water flow of White River at Hartford, Conn., at the age of nearly eighty years.

He has also spent much time in the course of his life in examining steam engines and boilers, testing various forms of the latter, taking indicator cards of engines, noting the value for combustion of various kinds of fuel, and experimenting on the value of lubrication of different kinds of oil.

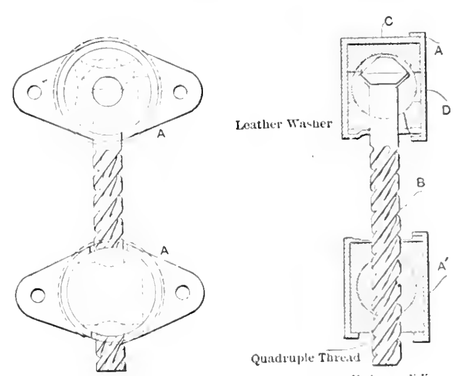
Much time, also, has been occupied in attendance of court and in making the necessary examinations and giving evidence in patent cases and law suits for water rights and damages, and also in examining the flow of streams which the owners proposed, if possible, to make useful as sources of power, visiting both Nova Scotia and Georgia for the latter purposes. He has been a frequent contributor to the technical press for many years, writing on questions of power and its transmission, mill construction and economy and various other topics. He has also been a student of natural history and interested in the fauna and flora of his native State. In 1876 he was appointed chairman of the New Hampshire Fish and Game Commission, and with the late Judge Sargent, of Concord, revised and compiled the fish and game laws of that State. He spent much time examining the lakes and streams of New Hampshire, introduced the fresh-water salmon into the lakes at the head of the Merrimac and Connecticut rivers, and endeavored to restock the Merrimac with sea-going salmon by constructing hatching houses and fishways.

This attempt was unsuccessful, as the fish would not return in any quantity, probably from the pollution of the waters by manufacturing establishments, and the effort was abandoned, but is worth noting. In closing this notice of his labors, he wishes to add, for the benefit of young engineers, the advice once given him by Mr. Francis: "Depend on your own careful observations and measurements rather than on text-books and printed authorities, which are often fallible and of doubtful value."

* * *

EDO SHOCK ABSORBER.

The development of the automobile has caused the breakage of springs on vehicles to be investigated much more thoroughly than had been the case prior to its advent, or perhaps it would be fairer to say that the high speed at which motor-driven vehicles are run so accentuated the trouble of spring breakage that it has assumed much greater importance than under former conditions, and consequently more is being done to prevent it. A leaf spring rarely breaks under the impact of road obstruction but usually on the rebound. When a rapidly moving car strikes a stone the shock is absorbed in the running gear and springs, the impulse not being communicated immediately to the body. But, after the obstruction is passed, the energy stored in the spring throws the body upward and its inertia carries it beyond the elastic limit of the spring, causing the break. A number of shock absorbers have been developed which work on the principle of offering no resistance to compression of the spring but which retard its reaction. An interesting example of these devices is shown in the accompanying cut being the "Edo"



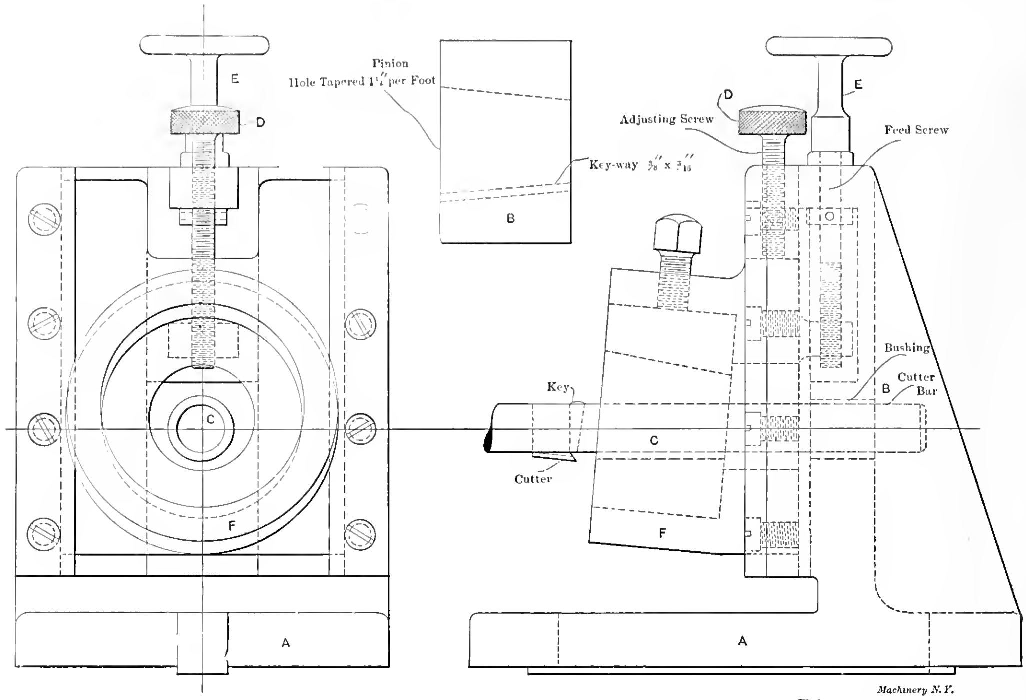
A Shock Absorber for Automobile Springs.

shock absorber applied by Beyer, Peacock & Co., Manchester, England, to a standard 5-ton steam motor truck. The Edo shock absorber is made in the form of a quadruple-thread screw *B* supported at either end by a phosphor bronze fitting *A* and *A'*, one of these being attached to the frame and the other to the axle. The lower bearing for the screw is a long nut, and at the upper end the screw has a cone head. This head is seated so that when the spring is compressed the screw revolves easily, the thrust being taken at the point of the screw at *C*, but the upward movement is retarded by the friction of a leather washer which is interposed between the under side of the head and the seat *D*. In one case the bearing is virtually a point and in the other case it is of considerable diameter, being the under side of the head and, besides, the frictional resistance of the leather is much greater than that of the metallic surface contact in compression. Consequently when the spring is compressed by the car passing over an obstruction there is little resistance by the shock absorber to this action, but its straightening out is retarded so that there is little or no possibility of the momentum of the body exceeding the elastic limit of the spring.

LETTERS UPON PRACTICAL SUBJECTS.

FIXTURE FOR SPLINING KEYWAY IN TAPER HOLE OF PINION.

The cut shows a fixture for cutting keyways in pinions with taper holes. The bushing *B* acts as guide for the cutter bar *C* at one end, the other end being fastened in the shaper ram in the ordinary way. The pinion is held at the required angle by the receiver chuck *F*, which is part of a vertical slide. The adjusting screw *D* gives the depth of cut, while the feed screw *E* raises and lowers the work for the cut and clearance when the tool is on the backward stroke. This fixture has given good satisfaction, being adapted to cut different sized pinions by using rings or bushings. I. N. Quire.



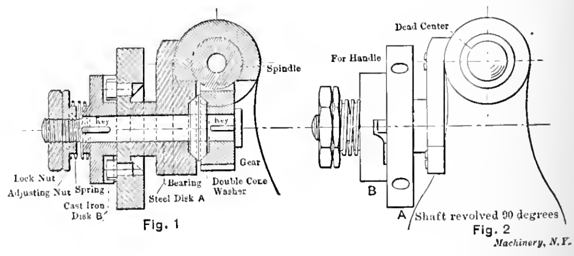
Fixture for Splining Keyway in Taper Hole of Pinion.

A QUICK-ACTING LOCK FOR THE TAILSTOCK SPINDLE.

Small lathes are often used for filing and polishing small pieces, or for winding springs and magnet coils, or for performing other operations that require the work to be frequently clamped between the centers and released. The device here described was designed to conveniently and quickly operate the tailstock spindle during such operations. One forward movement of the operating handle serves to advance the spindle until the article is clamped between the centers and locked firmly in that position. A reverse movement unlocks the spindle and withdraws it from the work. The construction of this device is shown in the cut.

The spindle has a suitable rack cut on its under side into which a small gear meshes for driving it. This gear is firmly keyed to one end of a shaft supported in a bearing as shown. The gear and the end of the bearing are recessed for the double cone friction washer. The shaft projects some distance through the bearing at the other end and carries the following parts: At the end of the bearing is a steel disk *A* which may revolve freely upon the shaft, and is provided with two projecting pins of bessemer steel and four holes for the operating handle. Next to this is the cast-iron disk *B* which can slide longitudinally upon the shaft, but is prevented from turning by a key. The disk has two slots shaped as shown in Fig. 2, into which the bessemer steel pins of disk *A* extend. The other side of this disk is provided with a small hub. The end of the shaft carries a nut and locknut. Between the nut and disk *B*, and supported by the hubs of each, are three or four turns of 1-16 inch steel spring.

The operation of the device is as follows: With the parts as shown in the figures the spindle may be considered as being drawn back. The pins of disk *A* are lying in the deepest portions of the slots in disk *B* so that the two disks are in contact. Revolving *A* by the handle inserted in one of the holes, the steel pins move in the slots in *B* and come against the inclined surfaces of these slots, thereby tending to force disk *B* away from disk *A*. This is resisted by the steel spring which prevents disk *B* from sliding longitudinally upon the shaft, consequently *B* revolves with *A* and by means of the key drives the shaft. This revolves the gear on the other end of the shaft thus causing the spindle to advance until stopped by clamping the article between the centers. This movement of the haudle may be from forty to sixty degrees. Upon the stopping of the revolution of the shaft, further movement of the handle, under somewhat increased pressure, forces disk *B* along the shaft as the steel pins ride out of the slots upon the plane areas provided. As the pins slide upon these areas the projecting hubs on the disk and nut come together which causes the shaft to draw the gear firmly against the friction washer and bearing, thereby locking the whole. This portion of the operation requires the handle to be moved through an angle of about forty-five degrees. Should the han-



Self-locking Tailstock Mechanism.

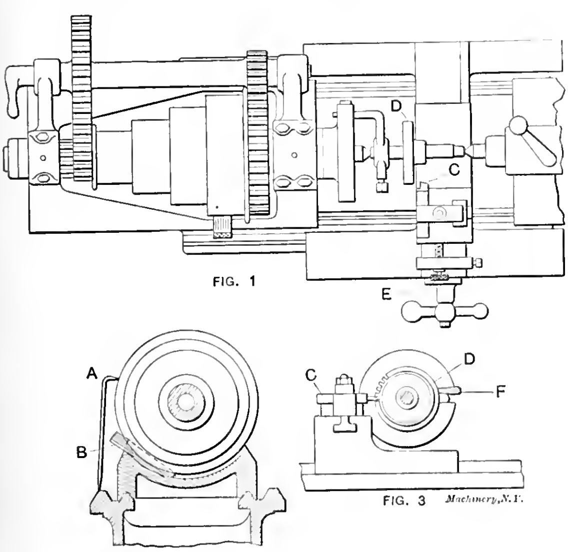
dle continue to be moved the steel pins will come against the little shoulders at the end of the plane areas which they cannot over-ride. Thus, the article is caught and fastened on the centers by one movement of the handle. To release the article the handle is moved in a reverse direction revolving disk *A*. Disk *B* would tend to follow in its locked position, but the shaft is held by the greater friction of the double cone washer and the gear. Therefore, disk *B* remains stationary as the two steel pins slide back into the deeper portion of the slots in disk *B*, which then springs forward bringing the two disks together, thus relieving the friction of the gear. Further movement of the handle revolves the mechanism bodily, drawing back the spindle.

A lathe equipped with this device has been in continuous daily use for the last two years and has required but one adjustment for wear. STEPHEN E. WOODBURY.

Cambridge, Mass.

CUTTING A GEAR IN A LATHE.

Figs. 1, 2 and 3 show a method of cutting gear teeth in the lathe which may be found useful where there are but one or two to be cut and it does not seem advisable to go to the expense of buying a cutter. As shown, the blank *D* is mounted on an arbor, and the tail of the dog which carries it is blocked in the faceplate slot by the wooden wedge *F*. The gear which was being cut in this case was to have 120 teeth. Since the back gear ratio was 12 to 1 the flange of the cone pulley was used as a dividing head with the back gears thrown in. The flange was stepped of into 10 spaces with the dividers. Since the pulley makes 10 revolutions to one of the work this gave the required 120 steps for cutting the teeth.



Method of Cutting Gears in Lathe.

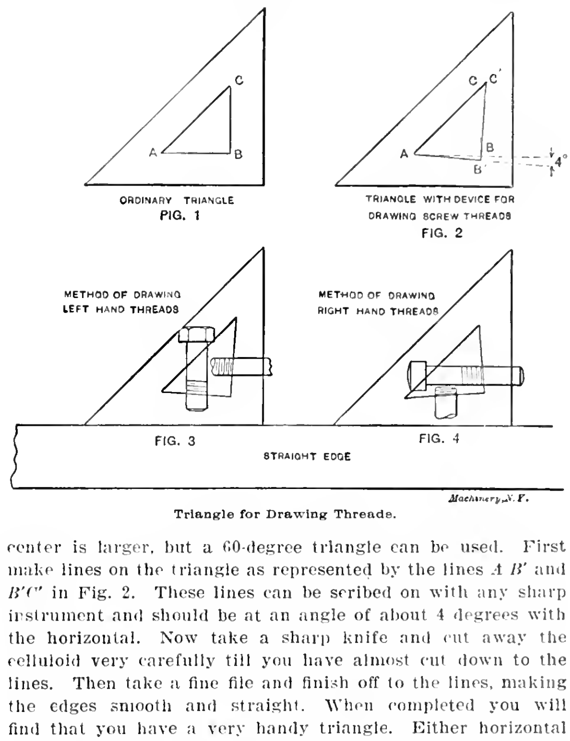
Wooden wedge *B* was driven in between the cone pulley and the head stock, just tight enough so that the cone pulley could be moved by hand without great difficulty. A scratch awl *A*, with one end bent at right angles and sharpened at both ends, was used to locate the divisions. One end of the awl was set in a prick punch mark on top of the front carriage *V*, and the scribed graduations on the pulley flange were brought around to the upper point of the awl one after the other, thus moving the blank into proper position for cutting the successive teeth.

A lathe tool was ground to the proper shape, blocked up to the center line of the lathe, and clamped in the tool post on its side. In cutting the teeth the regular screw cutting stop *E* was used to regulate the depth. The carriage was run back by hand, the tool fed in a little way, then the carriage was run forward, thus taking a planing chip out of the tooth space. The carriage was again run back, the tool fed in and run forward again, taking in this way successive chips until the proper depth had been reached as determined by the stop, when the blank was indexed as previously described and the operation repeated for the next tooth. If the lathe used has no stop such as is used for thread cutting, a block may be clamped on the cross slide way at the rear of the tool post to limit its inward movement. This will insure an even depth for all the teeth. JAMES MCCARTHY.

TRIANGLE FOR DRAWING THREADS.

Most draftsmen have more or less trouble in drawing the common representation of small screw threads. The accompanying illustrations show a simple device which makes this operation much easier, quicker and not so tiresome. The threads also can be made more uniform. Any draftsman can make this tool himself.

Take an ordinary celluloid triangle, as shown in Fig. 1; a 45-degree triangle is preferable as the opening, *A B C*, in the



Triangle for Drawing Threads.

center is larger, but a 60-degree triangle can be used. First make lines on the triangle as represented by the lines *A B'* and *B'C'* in Fig. 2. These lines can be scribed on with any sharp instrument and should be at an angle of about 4 degrees with the horizontal. Now take a sharp knife and cut away the celluloid very carefully till you have almost cut down to the lines. Then take a fine file and finish off to the lines, making the edges smooth and straight. When completed you will find that you have a very handy triangle. Either horizontal or vertical threads may be drawn without changing the position of the triangle, and right or left-hand threads are drawn by simply turning it over. J. W. COLEMAN.

Bridgeport, Conn.

TIME SAVING IN THE DRAFTING ROOM.

It frequently happens that the drafting room in a large plant gets behind in its work, and the shops commence to shout for drawings. It is not always advisable to send out pencil drawings, because, if there is to be any record kept of the work done in the drawing room, a copy of each drawing should be made before sending it out. Besides that, pencil drawings get mighty greasy and torn knocking around the shop or field. This not only makes it difficult for the workman to understand, but when it is finally returned to the drawing room, tracing it satisfactorily is all but impossible.

A quick and sure way to solve this problem is to trace the sheet upon tracing paper with a soft pencil. By making the drawing on the tracing paper, not only time but material is saved. This can be done in about one-third the time in which the drawing could be traced upon cloth. Care should be taken, however, to make the lines heavy, so that it will print well, and in passing it is well to state that curves and circles can be inked in more quickly and greater satisfaction be given than if they be put in pencil. If strips of drawing paper be pasted on the edges of the paper, it will not tear.

Another scheme for sending out copies of small or detail work is to have a cross section sketch book about seven and one-half inches by ten and one-half inches. Next to each cross section page should be a number of thin blank pages, preferably three. After the sketch has been drawn in lightly, carbon paper can be inserted between the sheets and the sketch gone over with a glass point or hard pencil. Then these carbon copies can be torn out and sent to the shops, the cross section page being kept for record. These books are handy alike for reference and filing. F. R. STEUART.

Sparrows Point, Md.

CASTING OUT THE "NINES" TO PROVE MULTIPLICATION AND ADDITION.

Frequently it is desired to prove a problem in multiplication, especially where the numbers are large and the final result of the problem depends entirely upon accuracy in the first multiplication. A short cut or simple method of doing this is by casting out the nines, and thus proving the product to be correct. Example as follows:

```
31416 —6 } 6 × 6 = 36; dividing by 9 remainder
 7854 —6 } equals 0.
---------
 125664
157080
251328
219912
---------
246741264 —0
```

In the multiplicand, after casting out nines $(3 + 1 + 4 + 1 = 9)$ we have a remainder of 6, also in the multiplier after casting out nines in the same manner we have a remainder of 6, multiplying the sixes together (6 times 6 equals 36) and dividing by nine we find a remainder of 0, therefore if the multiplication is correct after casting nines from the product in the same way as from the multiplier and multiplicand, we will have a remainder of 0.

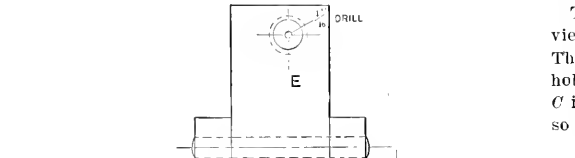
Addition may also be checked by this method, by adding the remainders and casting out nines instead of multiplying them and dividing by nines; the nines are to be cast out of the sum the same as in the product.

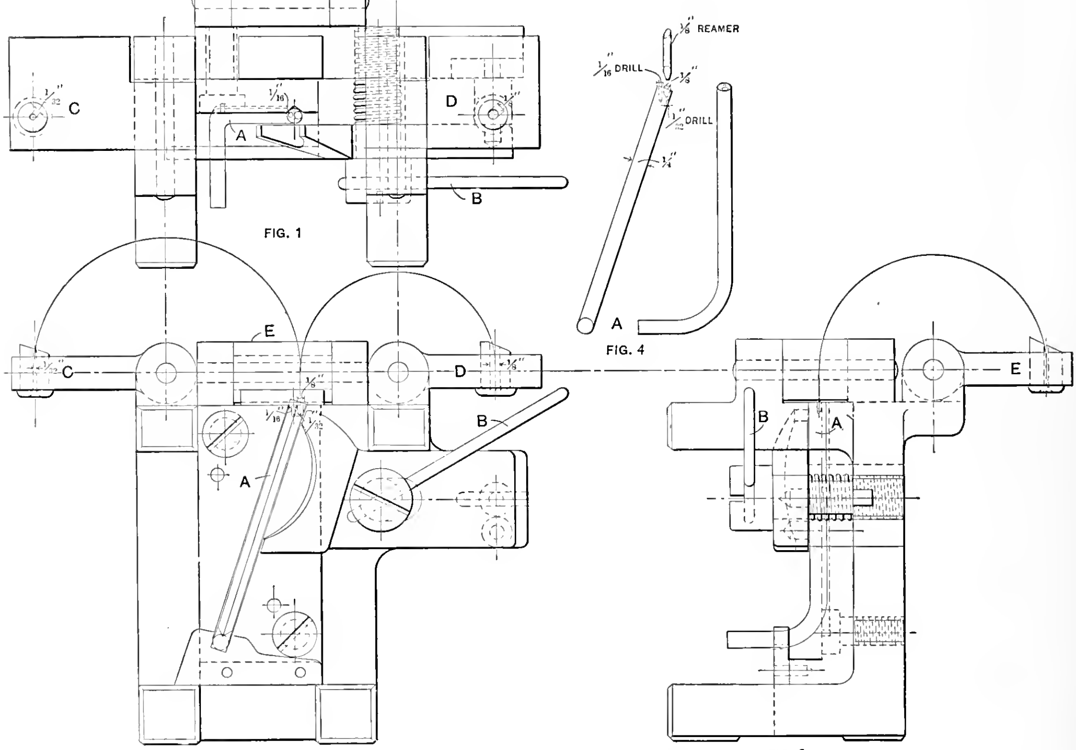
Meadville, Pa. E. W. BOWEN.

A COMBINATION DRILL JIG WITH MOVABLE LEAVES.

Fig. 4 represents a piece of work in which there are two holes in one end; one hole is straight, and the other is tapered, being drilled and taper reamed. It was first decided to make three jigs and make three separate operations, because the holes come so close to each other that it would be impossible to place all three bushings in one leaf of the jig. But as an alternative I suggested a jig as shown in drawing which has three leaves; it was made and gives perfect satisfaction. In using it the operations are as follows:

The work, *A*, is placed in the jig as shown in the three views and is fastened by means of a slide clamp and lever, *B*. The leaf *C* is then closed down into position and a 1/32-inch hole is drilled the full depth that the reamer is to enter. Leaf *C* is then opened and leaf *D* is closed, and reamer is used; and so on with leaf *E*, which completes the operations. L. J. G.





A Combination Drill Jig for an Unusual Operation.

SOME TRACING METHODS.

There are some things that a beginner in a drafting room should be told before commencing to trace.

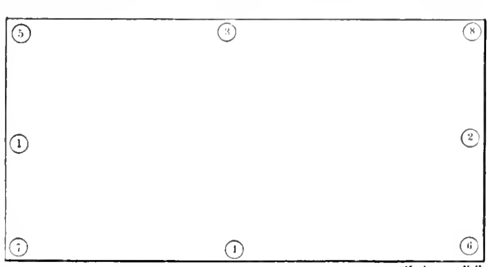
First, he should be taught how to tack the tracing cloth to the board. I have found from years of experience that the greatest satisfaction with the smallest amount of labor and thumb tacks is given by putting in the tacks as shown in the accompanying diagram. This applies, of course, when one has a large tracing to make. In the case of a small tracing, one tack in each corner will suffice.

It is immaterial which side of the cloth is used to trace upon. The advantages of the smooth or glossy side are that ink can be more easily erased, that it does not collect so much dust, and that the finished tracing looks better than when the dull side is used. But, when the glossy side is used the edges curl

up, unless the tracing cloth be re-rolled, which the majority of chief draftsmen will not permit; chalk, soapstone or some one of the many preparations made for this purpose, must be thoroughly rubbed in before ink can be used, and if, as in the case where the tracer also makes blue-prints, the cloth remains tacked down for a number of days and is worked upon only at infrequent intervals, this must be done not once, but a number of times. When chalk or anything else is used always be sure to either wipe it off with a clean cloth or brush it from the cloth thoroughly.

The next thing to do is to draw the border and trimming lines. The latter should be drawn in lightly, so that when the tracing is finished and trimmed it will present a neat appearance.

Under ordinary conditions it is always best to start in the upper right-hand corner of the sheet and finish the upper part



Arrangement of Thumb Tacks for Tracing.

of the sheet first. This insures the tracing being kept clean. Apropos of cleaning, I have found that the best rubber for cleaning is the bread rubber. It wears out very quickly, however.

When tracing an arrangement or a complicated detail, it is always best to trace in the top part first. For instance, there is a vertical steam cylinder to be traced; start on the plan and trace the gland first, because everything else will come under it. Then dot in the stuffing box, cylinder head, etc.

Always draw in the center lines first, then the outlines, dimension lines, dimensions and, last of all, crosshatch.

Keep all triangles, scales, protractors, etc., as clean as possible. Wash them weekly with some good soap and cold water. Do not use sandsoap or anything that will scratch them.

It is false economy to keep ink in ruling pens or other inking instruments. When through using an instrument for the time being, even if one is sure that he will pick it up again in a few minutes, it is always best to wipe it out. A clean linen cloth should be kept for this purpose. F. R. STEUART.

Sparrow's Point, Md.

METHOD OF ENLARGING OR REDUCING DRAWINGS.

Very often it is desired to reduce or enlarge drawings, scroll designs, letters, maps, etc. This can be done to scale or by proportional dividers but perhaps the simplest and quickest method is as shown in Fig. 1.

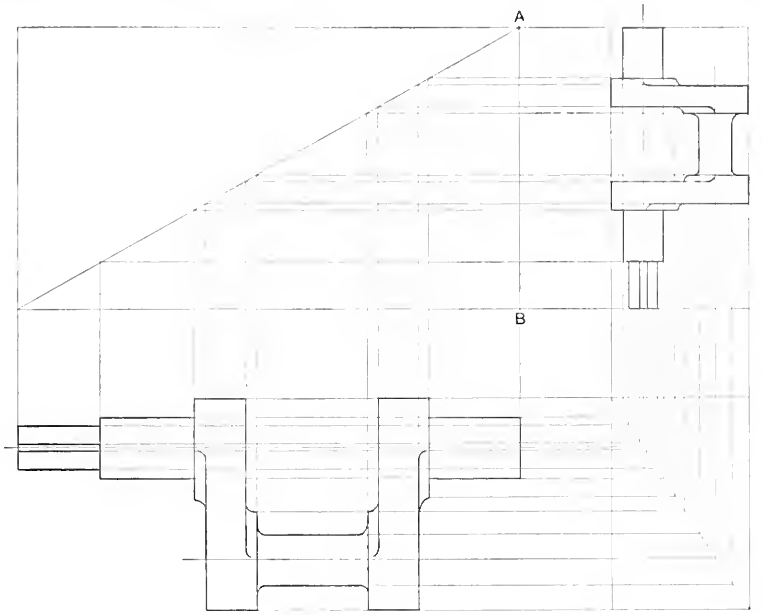


Fig. 1. A Method of Reducing the Scale of a Drawing.

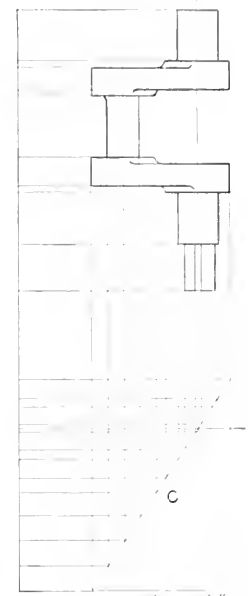


Fig. 2. Changing from Right to Left-Hand.

The only dimension necessary to lay off is the distance shown at *A B* which of course is the dimension desired for the reduced or enlarged copy. Fig. 1 shows the method for reducing which also applies for enlarging. It will be noticed that large and small rectangles are drawn with a diagonal line through each, and to these lines points are projected, and from there to the space where the copy is desired. The intersection of these lines are points of the copy.

Fig. 2 shows line *C* reversed from that shown in Fig. 1 which causes the copy to become reversed. This is especially con-

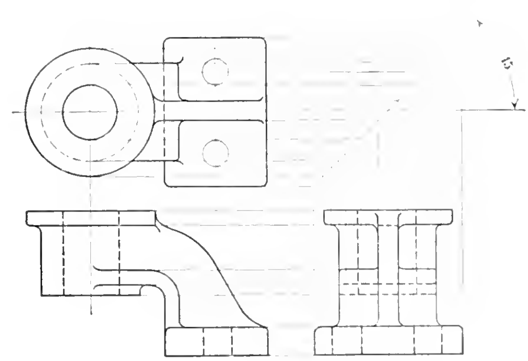


Fig. 3 Projecting the Third View

venient where it is desired to obtain a right and left of any object. In making the third view of an object when detailing it is more convenient to plot it as shown in Fig. 3 than by the usual method of scaling each dimension as it can be done much quicker and with less chance of error. The diagonal line should of course be at 45 degrees in this case. In actual use, dashes cutting the diagonals are sufficient, instead of the construction lines shown in the above cuts. WINAMAC.

SOME DOGS AND DRIVERS.

The dogs and drivers illustrated and described in this article will probably not be new to all the readers of MACHINERY as they are old, tried and true friends in the shops where they are being used, but may perchance fill a long-felt want for somebody on the lookout for something of this kind.

Fig. 1 shows a style of dog used extensively in the grinding department on small work, say ⅛ to ⅜ inch diameter and highly finished, where it is necessary that the work be

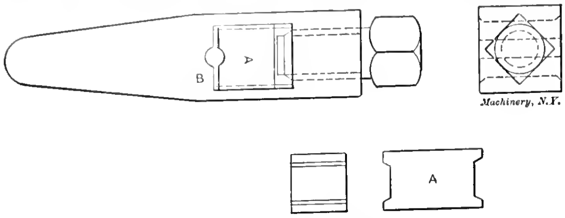


Fig. 1. A Dog for Grinding Small Work.

gripped tightly but without marring the finish. Two grades of these are used; one grade for the lathe work, being a finished forging with hole carefully forged in and having no finish afterwards except filing the edges and corners rounding. The other grade is not so carefully forged and is finished all over, including the hole. The construction can readily be seen from the sketch. The jaw *A* is shown sepa-

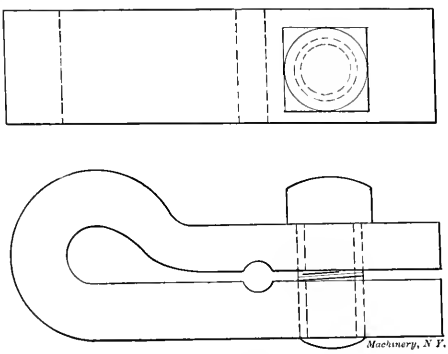


Fig. 2. A Dog for Grinding at Low Speeds.

rately in the lower view, Fig. 1, before being staked in. After the jaw is staked in it is tapped lightly with a hammer until it will slide easily on the beveled edges of the slot. A piece of sheet steel 1/16 inch thick is put in between the jaw and the dog at *B* and the jaw is tightened down on it by the screw. The piece of sheet steel is then center punched for the hole. The holes are drilled and

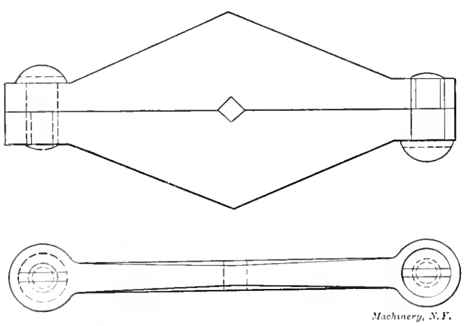


Fig. 3. For Light Grinding on Tool Work.

reamed in a four-jaw independent chuck. After drilling and reaming they are carefully balanced so that at 1,000 revolutions per minute there will not be the slightest flutter in the work being driven. The dog is made of tool steel, the jaw of soft steel and the screw of tool steel, hardened.

Fig. 2 shows another type of driver used on a coarser grade of work which does not run at as high speed and consequently does not have to be so carefully balanced. Hence it has no finish; just a forging tapped, drilled and reamed.

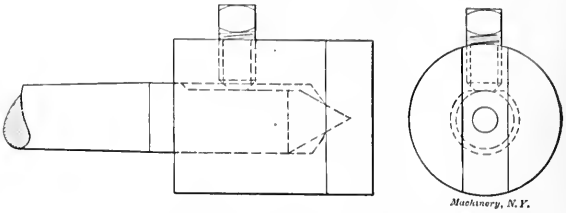


Fig. 4. For Driving Thumb-screws in the Lathe.

Fig. 3 shows a driver used on the universal grinders for tool work which is very handy for light grinding. It is made of tool steel finished all over, and with three sets of screws it will hold pieces of any shape and size within its capacity.

Fig. 4 is a driver for the lathe which was made when some thumb screws were to be turned and threaded. The idea proved so good that it has been extended so that there

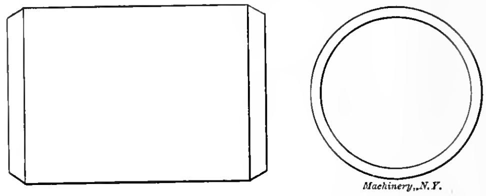


Fig. 5. A Difficult Piece to Handle in the Grinder.

is a set of drivers for all shapes and sizes. The chief advantage of this idea is that with one center for each lathe, turned to one inch in diameter, the drivers will interchange with all the lathes. A pointed center is made about ½ inch longer than the usual center and flattened for the screw used with the drivers. The drivers are of cast iron and one can be made in about half an hour, as there is no finish necessary.

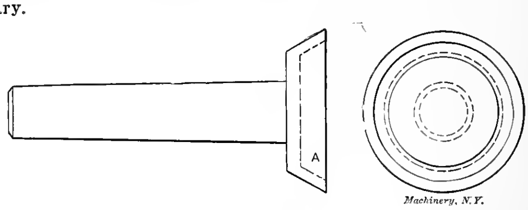


Fig. 6. Head Center for Driving Piece shown in Fig. 5.

Fig. 5 shows a hardened tool steel roll 2 inches diameter by 3 inches long, of which we grind quite a number. This roll can have no center holes, so some sort of friction driver is needed, and Figs. 6 and 7 show the driver and center for the grinder.

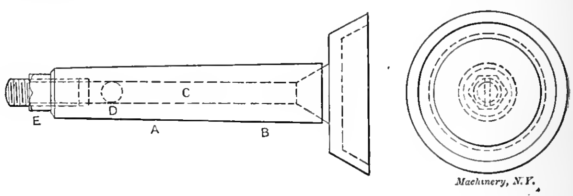


Fig. 7. Tail Center for Supporting Piece shown in Fig. 5.

Fig. 6 is the headstock driver hardened on the driving end and ground on the inside at *A* to fit the beveled ends of work. Fig. 7 is the tailstock center. *A* is a taper sleeve fitting the center hole in the tailstock spindle, and is hardened on outer end as far back as *B*. *C* is the revolving center, made a running fit in the ¼ inch hole. *D* is a ¼ inch tool steel ball and *E* is an adjusting screw and check nut. When in use the screw is adjusted so that when *C* is bearing against the

ball tho tapers are lightly touching. This center is used on a universal grinder with a spring tailstock spindle.

Fig. 8 is a friction driver used in the centering machine for centering shafts from $\frac{3}{8}$ to $\frac{7}{8}$ inch in diameter and from 2 to 4 feet long. It is made of tool steel, hardened.

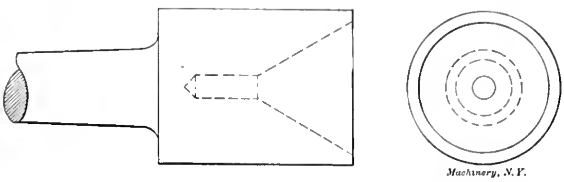


Fig. 8. A Friction Driver for the Centering Machine.

Fig. 9 is a driver for the shafting lathe when filing and polishing shafting; it is made of tool steel.

A square 60 degree center can be used to advantage for light grinding. We have a number of taper pins to grind 4 inches long, 7/16 inch diameter, on the large end and 5/16 on small, and we found the best way to grind these was to

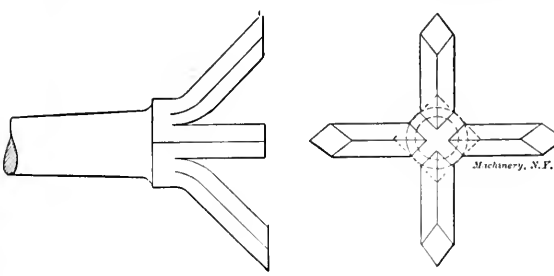


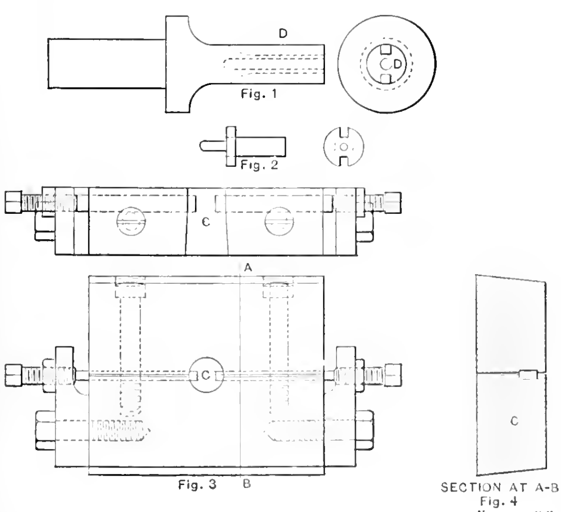
Fig. 9. A Driver for Polishing Shafting.

use a square center finish ground in the machine on the sides of the square so that the corners will run true. This center is of course used with a spring tailstock spindle.

Lowell, Mass. PAUL W. ABBOTT.

A BROACHING DIE.

The accompanying cuts illustrate a form of die that I have never seen published in MACHINERY, although the principle is adaptable to numerous blanking dies that are both difficult



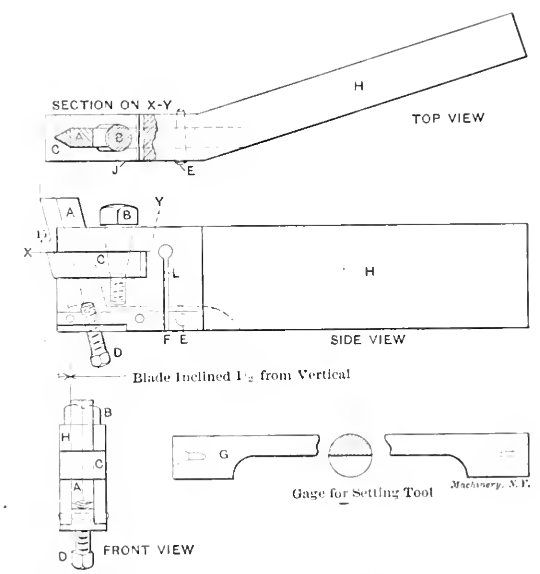
A Die for Broaching.

and expensive to make solid. The cuts illustrate the principle of construction clearly enough so a brief description will be sufficient. The part to be broached, Fig. 2, is made from brass rods in the screw machine, and the die was made to cut the two slots or keyways in the flange. The large end of the stud is set into the die (or punch in this case), Fig. 3, and rests upon the two projecting blades or cutters, C. This position of the stud brings the flange within the recess, which centers it. As the punch (or die in this case), Fig. 1, descends the small end of the stud enters the hole, D, in the center of the die which serves to keep it straight during the cutting operation. The die descends far enough to carry the flange of the stud past the end of the cutters C so it will drop through or be stripped when the die ascends. As indicated in the cuts, the cutters are provided with adjustment so that they may be ground when dull. T. J.

COMBINATION THREADING TOOL.

The cut shows a combination spring and solid threading tool which I found to be the best I ever used, especially for working on tool steel. Here are some of its good points. First it is made high enough so as to go on the carriage instead of on the rocker of the tool post. Therefore the tool is always parallel. Second, the cutters are easily and quickly made and may be quickly changed in the holder from "V" to U. S. S. thread. I have made as many as six in an hour. Third, the blades may be easily set, by bringing the face of the holder at J parallel to the face plate and raising the cutter to the center line with the set screw D. The gage shown at G, which consists of a smooth piece of round stock centered at the ends and milled out to the center line for a short distance, furnishes a convenient means for locating the top of the cutter at the proper height.

The construction of the tool will be readily understood. A slot is milled out on the front end of holder H at an angle of



A Convertible Spring or Solid Threading Tool.

15 degrees, to receive the blade A. This slot, as shown in the front view, also has an inclination of 1$\frac{1}{2}$ degree from the vertical to make the cutter agree with the average inclination of the thread in a U. S. standard screw. In a horizontal slot in the end of the holder is fitted the clamping yoke C. The top view shows this piece quite plainly. It has an opening in it through which the blade A passes, and is provided with a tapering seat for the tightening screw B. As this is screwed down, yoke C is drawn in and the blade A is held firmly back against its seat; screw D adjusts the blade for height. A saw cut at F extends nearly through the holder thus leaving the upper end flexible to give it the effect of the well-known gooseneck tool. Through a slot in the bottom is passed the tie piece F which is pinned fast to the outer division of the holder and may be, if so desired, connected with the shank by the taper pin E. This allows the tool to be used either as a solid or as a spring tool holder. EVERETT KNEEN.

Kearny, N. J.

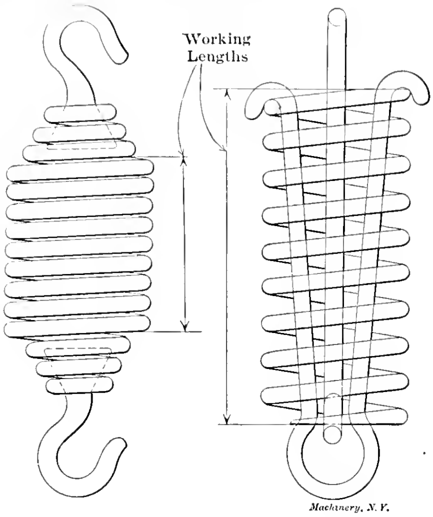
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

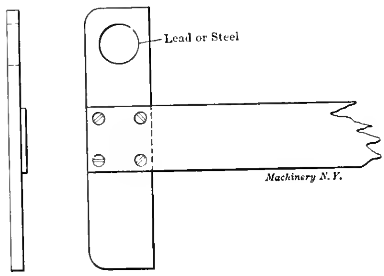
TO INCREASE THE WORKING LENGTH OF COIL SPRINGS

The sketch shows two springs, one as usually constructed and one which is not commonly used but which has a number of advantages over the former. It will be noticed in one that a hook with a conical end is inserted in each end of the spring, and the coils are then pinched around it. This not only requires special hooks but necessitates forming the ends of the spring which in itself is no easy job, especially when the larger sizes of wire are used. Another disadvantage is that where only a limited space can be had for the spring a good share of it is taken up by the ends and no benefit derived therefrom. The object of the improved manner of using a spring is to use it under compression instead of under tension, as this is preferred when it can be done. Two U-shaped pieces are formed and inserted in the spring, which allows the full length to be used. WINAMAC.



WEIGHTED T-SQUARE HEAD.

The accompanying cut shows a T-square which I have used for some time with good results. A 1½-inch hole is bored in the upper part of the head and a piece of steel is inserted.



The upper part of the head being the heaviest, it always tends to keep the upper edge of blade down close to the board. GORDON F. MONAHAN.

Bridgeport, Conn.

METHOD OF DIVIDING FRACTIONS BY TWO.

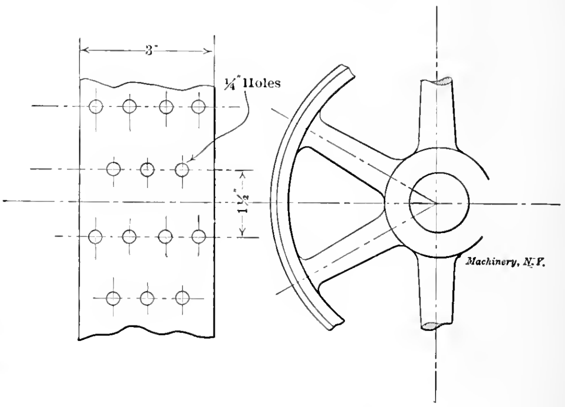
Perhaps the readers of MACHINERY will be interested in the way I divide fractions by 2. I refer to a table of decimal equivalents and find the fraction which is to be halved, as, for example, 11/64; instead of dividing by 2, multiply by 5, giving as a result 55/64. Now, opposite 55/64 will be found the decimal equivalent 0.859375. Point off another decimal place, as there must be one more decimal place in the result than in the decimal equivalent, for the decimal equivalent is, of course, ten times too large. Hence, the answer is 0.0859375. To halve a mixed number by this method, as, for example, 17 9/32, multiply both the whole number and the fraction by 5, pointing off one place as before, in each case. $17 \times 5 = 85$; $9/32 \times 5 = 45/32 = 1\ 13/32 = 1.40625$. $8.5 + 0.140625 = 8.640625$. By this method any fraction can be halved and the results read direct from the table with little liability of error. I find it very convenient when laying out dimensions each side of a center line or finding the radius of a circle, especially when the dimensions include 64ths, as, for example, 11 19/64.

Another good method is to use the February data sheet, in which the values of fractions are expressed in 64ths, as, for example, 13 7/16 = 860/64, which divided by 2 = 430/64, and by referring to the data sheet table, the equivalent is found to be 6 23/32. LOUIS F. LANG.

Boston, Mass.

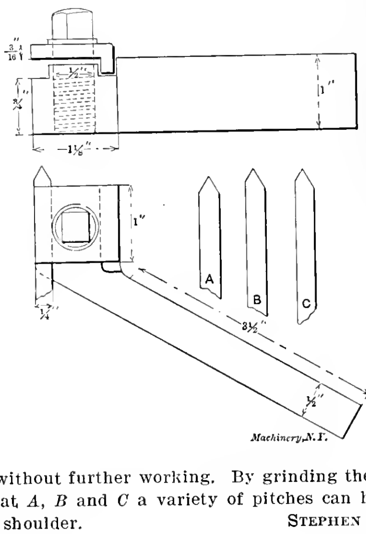
TO PREVENT THE SQUEAKING OF LOOSE PULLEY BELTS.

If there is one thing annoying in the machine shop that should be avoided it is the constant squeaking of the tight pulley on the planer and emery wheel while the belt is being shifted. This can be prevented by drilling a series of holes in the rim as here shown. WINAMAC.



THREADING TOOL HOLDER FOR HIGH-SPEED STEEL.

The cut shows a toolholder which I devised for the economical use of high-speed steel in thread cutting. One advantage of the holder is that cutters can be broken off from the bar and used without further working. By grinding the cutters as indicated at A, B and C a variety of pitches can be cut close up to the shoulder. STEPHEN COURTER.



Paterson, N. J.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

214. TO WRITE ON CELLULOID.

To write on triangles or other instruments made of celluloid use anhydrous acetic acid. The writing will appear dull on the shining surface. If colored writing is desired add some coloring matter to the acid. J. M. MENEGUS.

Los Angeles, Cal.

215. IRON OR STEEL?

To find out whether a piece is steel or iron touch it with nitric acid, using a stick of wood, and then wash it with water. If iron, a light or azure stain will appear; if steel, the stain will be black. J. M. MENEGUS.

Los Angeles, Cal.

216. VARNISH FOR IRON WORK.

To make a varnish for outdoor wood and ironwork, dissolve in about 2 pounds of tar oil ½ pound of asphaltum and a like quantity of pounded rosin; mix hot in an iron kettle, care being taken to prevent any contact with the flame. When cold the varnish is ready for use. JOSEPH M. STABEL.

Rochester, N. Y.

217. ALUMINUM SOLDER.

To make a solder for soldering aluminum, melt together 1 pound block tin, 4 ounces spelter, 2 ounces pure lead and 3 pounds phosphor tin. When using, clean the work with benzine and apply with a heated copper bit in the usual manner. L. C. CARR.

Lynn, Mass.

218. CEMENT FOR ATTACHING METAL TO GLASS.

To make a cement for attaching metal to glass mix 2 ounces thick glue, 1 ounce linseed oil, ½ ounce turpentine. Boil together for a short time when it will be fit for use. Apply hot with a brush and clamp the parts together for about two days to allow the cement to dry. R. M. K.

219. LUBRICATING MIXTURE FOR CUTTING THREAD IN TOOL STEEL.

To make a good lubricating mixture for cutting thread in hard tool steel, use equal parts of turpentine and benzine or kerosene. For cutting in soft tool steel mix equal parts of kerosene and lard oil. These mixtures always flow even and keep just about enough moisture at the cutting point.

Kearney, N. J. EVERETT KNEEN.

220. CLEANING SOLUTION FOR BRASS.

To make a cleaning solution for brass work mix 1½ ounce nitric acid, 1 drachm saltpeter, 2 ounces rain water. Let the mixture stand a few hours and then the articles to be cleaned may be dipped in quickly and then rinsed off and dried. R. M. K.

221. TO BRAZE STEEL AND IRON WITHOUT HEAT.

To braze steel or iron without heat take ¼ ounce fluoric acid, 2 ounces of brass filings, and 1 ounce of steel filings. Put them all into the fluoric. Touch each part of the work with the mixture, and put them together. Take care that the fluoric acid is put into an earthen vessel.

Rochester, N. Y. JOSEPH M. STABEL.

222. GLYCERINE-LITHARGE CEMENT.

A handy cement to have in the shop for stopping leaks, etc., and which can be used for cementing glass, brass, etc., is made by mixing equal parts of litharge, commercial glycerine and Portland cement. This cement will harden under water and will withstand hydrocarbon vapors. O. E. VORIS.

Dayton, Ohio.

223. BICYCLE TIRE ANTI-LEAK.

Many machinists ride their bicycles to and from work and are consequently interested in anything that will make tires more nearly puncture-proof. I have not tried the following anti-leak compound, but infer from a note in the *English Mechanic* that it works successfully on both single and inner-tube tires. Mix ¼ pint of silicate of soda (water glass), ¼ pint of commercial glycerine and a large tablespoonful of rubberine; inject about a teacupful into the tire. If too thick, a little water can be mixed with it to thin it. If rubberine is not available use powdered rosin. M. E. CANEK.

224. TO PUNCH HARD RUBBER.

To punch hard rubber successfully heat the punch and die, or the material. The blanks usually curl or wrinkle into almost every conceivable shape in the operation of cutting. To straighten and bring them back to their original outline, allow the punchings to drop into a pan of hot water. The action of the hot water causes the curled parts to return to their former flat position the same as before passing through the die. L. C. CARR.

Lynn, Mass.

225. TO MAKE VANDYKE PRINTS MORE TRANSPARENT.

To a pint of best grade gasoline, add as much paraffine as the gasoline will readily dissolve and spread this solution evenly over the print with a soft brush, wipe dry with a piece of white cotton rag and print in the usual manner. Vandyke prints treated in this way will require only about two-thirds the usual time to print. E. W. BOWEN.

Meadville, Pa.

[A sample Vandyke "negative" partially treated in this manner shows a marked increase in transparency; a blueprint made from it is overprinted on the treated side and under exposed on the other.—EDITOR.]

226. TO PLATE POROUS WORK.

In the plating of brass or cast iron, or other porous metals there is more or less trouble with what is called "spotting out" which is caused by the cyanide getting into the pores, and it has been hard to find a satisfactory remedy for this trouble. The following can be used with good results: First, give the work a good stiff coat of nickel, then put it through a brass solution without buffing. After the required deposit has been obtained, rinse it in cold water, and then hang in boiling water, as long as possible without tarnishing. Then hang it in a good hot oven until thoroughly dried out, after which buff and hang for a few moments in gasoline, and put it in the oven again. You will find this will cure a great deal of the trouble experienced on that class of work. This is a valuble process and one never before printed.

Bridgeport, Conn. J. L. LUCAS.

227. FOR COLORING BRASS BLUE BLACK.

To color brass blue black make a solution of ammonia and copper carbonate in the approximate proportion of 10 parts of ammonia and one part of copper carbonate by weight. Shake the mixture well until the copper carbonate is dissolved, adding the copper carbonate to the ammonia little by little until the ammonia will not dissolve any more; then add a volume of clear water equal to about one-fourth of the mixture. The pieces of brass to be colored should be polished bright, either with fine dry emery cloth, taking care not to touch the polished surface with the fingers, or made clean and bright by dipping in a strong solution of caustic soda. Before dipping agitate the compound thoroughly and then immerse the pieces of brass, keeping them in motion two or three minutes, rinse off in clean water, and dry in sawdust or clean cotton waste. When not in use the solution should be kept in a tightly-corked bottle. I have used it on instrument work very successfully. H. M. WEBER.

Cambridge, Mass.

* * *

A number of accidents which have occurred recently to British fishing vessels have been attributed to the magnetized condition of the sheath-knives carried by the sailors deflecting the compass needle, says the *Electrical Review*.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

21. B. C. W.—The question arose in our tool department as to the proper size to drill a tap hole for a 14—24 tap. The following handbooks and tables were referred to with the following results:

Saunders' Handbook	Drill No. 7
Morse Twist Drill Co.	Drill No. 9
Starrett's Gage Chart	Drill No. 6
Murdock's Table	Drill No. 4
Standard Drill Co.	Drill No. 10
Machinery Data Sheet (V-thread)	Drill No. 8

Will you kindly inform us through your valued column, or otherwise, why there is so much difference?

A. It will be seen that the various sizes given, range between No. 4 and No. 10. This variation, however, is not so great as it sounds. A No. 4 drill is 0.209 inch in diameter, while a No. 10 has a diameter of 0.1935 inch, a difference of only 0.0155 inch, which is no more than enough to cover varying conditions for a tap of this size. For a theoretically full sharp V-thread the proper amount to subtract from the outside diameter of the tap to give the diameter of the tap drill can be found by dividing 1.732 by the pitch. This will give us in this case, $1.732 \div 24 = 0.0721$ inch. Subtracting this from the outside diameter of the tap, we have $0.2421 - 0.0721 = 0.170$, which is practically the diameter of a No. 18 drill. This, however, would not be at all a practical size to use. The action of a small tap varies with its condition as to sharpness and hardness, and the material in which it is used. A sharp new tap in good cast iron will cut quite a clean chip, so a tap drill nearly as small as a No. 18 might, perhaps, be used, although it would quite likely give so sharp a thread as not to admit the more or less imperfect commercial machine screw, and it would also probably take so much force in tapping the hole as to make it difficult to keep from breaking it. In steel, on the other hand, even with a new tap, but to a much greater degree with one slightly worn, the action is only in part that of cutting; the thread is to a large extent formed by pressing the metal into shape. For this reason the drill needs to be quite a little larger than that theoretically called for, since much less metal is removed than in the previous case. The duller the tap and the softer the metals the more noticeable is this action, until in the case of some grades of brass the tap may do almost no cutting, the thread being formed by pressing the metal into shape. For this, a drill about half way in size between the outside diameter of the screw and the tap drill, as theoretically determined, should be used. This, it will be seen, gives as great a variation as that called for by the various tables our correspondent consulted.

The Brown & Sharpe Mfg. Co. in their automatic screw machine work make regular use of the following table in determining the sizes of tap drills. The results given by this table require a somewhat larger drill than would be necessary for hand work, since here there is less danger of breaking the tap than there is in the machine. If the tap is going hard the workman can remove it, clean, oil, and start in again, the cleaning process being repeated as often as may be needed to screw the tap safely to the bottom of the hole. The table and the accompanying directions are copied from their treatise on the automatic screw machine.

TABLE FOR USE IN SELECTING TAP DRILLS.

Threads per inch.	Theoretically Full Thread. Double Depth = $\frac{1.732}{P}$	Amount to be subtracted from Outside Diameter of Tap for Tap Drill Size.
74	.0234	.009
72	.0240	.009
70	.0247	.010
68	.0254	.010
66	.0262	.010
64	.0270	.011
62	.0278	.011
60	.0288	.012
58	.0299	.013
56	.0309	.014
54	.0320	.014
52	.0333	.015
50	.0346	.016
48	.0361	.017
46	.0376	.022
44	.0393	.023
42	.0412	.025
40	.0433	.026
38	.0456	.027
36	.0481	.029
34	.0510	.030
32	.0540	.032
30	.0577	.035
28	.0619	.037
26	.0665	.044
24	.0720	.048
22	.0786	.052
20	.0865	.057
18	.0961	.064
16	.1080	.072
14	.1238	.082

"The sizes for tap drills given in the above table are from 4-10 to 66-100 of a full thread; the former amount being allowed on fine threads, as these are usually for small screws. These sizes are only approximate, and often even larger drills could be used and the work be as good as is required for the purpose for which it is to be used. In other cases the thread must be nearer full and then it is usually desirable to use two taps, thus dividing the work. Machine screw taps to fit the usual commercial screws are usually from 0.008 to 0.016 inch larger than the size usually given in tables for the diameters of machine screws, and the amount given in the table above should be subtracted from the actual size of the tap as measured by the micrometer. For example: The size of a No. 12 screw is usually given as 0.2158 inch diameter, but the taps will measure from 0.219 inch to 0.224 inch. Then, taking the average, 0.222 inch, and deducting .048 inch, the amount given in the table for 24 threads, the result, 0.174 inch for the tap drill, gives as full a thread as is usually practicable for use in an automatic screw machine; and many times even larger tap drills are used."

It will be seen from the above that on these small taps, especially, the question of sizes of tap drills is one that varies with the condition of the tap, the nature of the material to be worked, and the way in which tapping is done, whether by hand or machine. It will be noticed that the size as given in the data sheet is about the average of the various sizes given, so it may be taken as representing good average practice, which is, however, to be varied to suit the special conditions of the work in hand.

* * *

A LARGE EDITION.

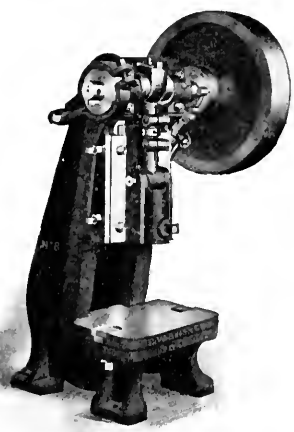
At the time this was written the New York Telephone Company began the work of delivering the new summer telephone books for New York and vicinity, and collecting the old ones. The edition filled 25 freight cars and weighed 400 tons. About 200 men are employed for the distribution, which takes about four weeks to complete, and means the handling of about 800 tons of paper, since the old books are taken away when the new ones are left. This is done for the protection and convenience of the subscriber, and to prevent the use of the old directories which would result in the giving of many wrong numbers, and would be, in consequence, a drag on telephone service. The new directory contains the names of over a quarter of a million of business houses and individuals—365,000 books were distributed. Originally the telephone book was used only for the purpose of looking up telephone numbers, but at the present time the list of telephone subscribers in New York city is so complete that the telephone directory has become the best general directory of New York and vicinity, and is almost absolutely accurate since it is revised and a new issue distributed every four months. An advertisement recently issued by the telephone company illustrates graphically the extent to which this feature has grown. It is in the form of a picture showing side by side Mount Everest, the highest mountain in the world, and a tower of 365,000 telephone books, one on top of another, which makes a column 6¾ miles high, towering over a mile above the top of the mountain.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

SMALL BLISS PUNCH PRESS.

The press shown below is interesting from its small size and from the fact that it is designed to take the place of the usual foot press in lines of work in which that tool has been extensively used; it is particularly adapted for making such parts as are used in the manufacture of burners, light jewelry, etc., and it may be employed as well for small punching, blanking and forming. The general lines of the press are similar to those of the regular Bliss inclinable style, although some slight changes due to the small size of the machine have been made. The ram adjustment is obtained by a split sleeve connection having a right and left-hand thread. The adjustment is made by turning the adjusting screw, which is securely locked by means of the two bolts shown. The press is fitted with the maker's two-piece clutch, which is practically instantaneous in its action. The wheel is bronze bushed, and has a solid web.



Small Bliss Punch Press.

The principal dimensions are: Opening in bed, 3 inches in diameter; distance back from center of slide, 3 inches; width of opening in back, 4 inches; distance from bed to slide, ram and adjustment up, 5 inches; length of stroke, 1 inch, although the press can be made with a 2-inch stroke if desired. The balance wheel runs from 150 to 200 revolutions per minute. The bench space required over all is 16 inches x 16 inches. These presses are made in large quantities with suitable jigs and gages, so that the parts are interchangeable, and low priced as well, thus enabling the press to be put on the market at a very reasonable figure. The E. W. Bliss Co., 5 Adams St., Brooklyn, are the builders.

FINISHING BOX TOOL.

The box tool shown in the accompanying halftone is designed to make available for the ordinary round turret the advantages of the tool with rocking adjustment, so successfully used on flat and hexagon turret lathes. The advantages of the tangent or "over shot" blade are: it is a free and rapid cutter; its controlling cam allows the cutting edge to be cleared from contact with the finished work on the return while the machine is running, thus avoiding marking of the work; and the construction allows the relieving or turning of work to a smaller diameter for any desired distance between two larger diameters. The adjustable back-rest jaws supplied with this type of tool have a burnishing effect that produces a smooth finish. This style of tool can be adjusted for size much more quickly than can the old form of box tool with fixed blade, and is very rigid in its action. The cutting tool can be set to precede or follow the back-rest jaws. It is made by the Garvin Machine Co., Spring and Varick Streets, N. Y. There are several sizes in the line, with a maximum capacity for work 2 inches in diameter with a length of cut of 4 inches.

Garvin Finishing Box Tool.

A CONVENIENT DRAFTING TABLE.

The drafting table shown in two different positions in Figs. 1 and 2 is made by C. E. Hemp, Hamilton, Ohio. The frame or base of the table is made of oak, strongly put together, varnished and finished with a dead gloss. The frame which holds the drawing board is made of white maple. The board itself is of white pine; it may be fixed at any angle by the use of two handscrews, and is raised or lowered to any height desired by operating the crank on the side. As may be seen the frame is mounted with nickel-plated brass fittings for a parallel ruler which is part of the outfit. This table will be furnished with a plain top, if desired, instead of with the drawing board top as illustrated, or quotations will be furnished on other sizes than the standard, which carries a board 21 inches high and $41\frac{1}{2}$ inches long. Extra boards, which are removable, will be furnished at a slight additional cost.

Fig. 1. Drawing Table, with Board Horizontal.

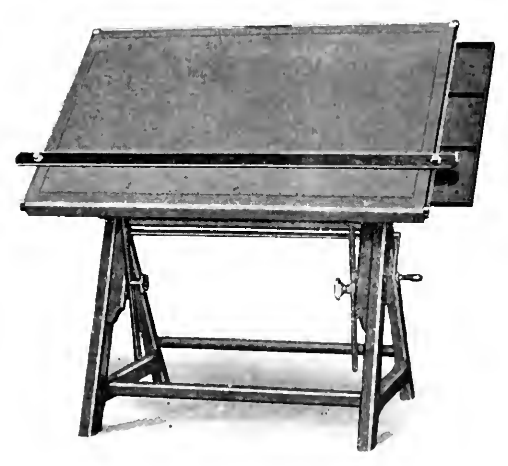


Fig. 2. Drawing Table Elevated to Angular Position.

OBITUARY.

Loring Coes, a well-known inventor and manufacturer of Worcester, Mass., died July 13 at the advanced age of ninety-four. He was born in Worcester, April 22, 1812, and had been identified with that community from his birth as carpenter's apprentice, journeyman, and founder of several enterprises which developed into important local industries. He was a remarkable character in many respects, and perhaps, with the exception of Mr. Chas. Haswell, the engineer, was the oldest man actively engaged in business in America. Up to the six months' sickness immediately before his death Mr. Coes had practically never been sick or lost a day by indisposition of any kind. Although an important factor in the knife and shear-blade manufacture and an inventor of improved methods of manufacture, his name in most minds, is indelibly associated with the screw wrench.

As a boy, Loring Coes was apprenticed to a carpenter at the age of fourteen, working thus until twenty-two, and then for two years as a journeyman. Then, in 1836, he and his brother, Aury G. Coes, started in business in Worcester, in the manufacture of woollen mill machinery, in the old plant of Kimball & Fuller. This building was destroyed by fire two years after its purchase by the Coes Brothers, whereupon they went to Springfield, Mass., as patternmakers. It was here that Loring Coes invented the improved screw wrench in 1839 and the manufacture was begun in Worcester in 1840. In July, 1853, the shear and knife business of Moses Hardy was purchased, and this was conducted along with the wrench business, both ventures proving successful. In 1869 the brothers separated, each forming a new company, A. G. Coes, in company with his son John taking the shear blade business under the name of A. G. Coes & Co. and Loring Coes taking the machine knife works. The Coes patents having expired, in 1871 Loring Coes built a new large factory for the manufacture of the monkeywrenches which he had invented more than thirty years before. In 1875 A. G. Coes died and his two sons continued his share of the business, making shear blades and wrenches as well, until 1888, when a joint stock company was organized and incorporated to manufacture the inventions of Loring Coes, under the name of the Coes Wrench Co. In 1902 Loring Coes acquired the stock and business of the Coes Wrench Co. and was made president, and this is the company which is now making Coes wrenches in Worcester. The accompanying photograph is one that was published in MACHINERY, April 1902, and was taken when Mr. Coes was ninety years old. He was a remarkably active man at this great age, and for forty-four successive years had taken an annual outing in the woods of Maine, to which relaxation he attributed in large measure his long life and freedom from sickness. In MACHINERY, June, 1902, a reproduction of the original Loring Coes patent (reissued in 1849) was published, which showed that in all essential particulars the wrench is practically unchanged up to the present time. While Mr. Coes has been a great improver in the screw wrench since his original patent was taken out, these improvements have been largely in the details of the handle, always a troublesome part.

Loring Coes.

Louis Cassier, publisher of *Cassier's Magazine* and the *Electrical Age*, was killed at Salisbury, England, July 1, in a wreck on the London & South Western Railway. Mr. Cassier was born in Boston in 1862, and was in common expression, a "self-made" man. When a boy of about eighteen he became a reporter on the *Boston Transcript* and combined reporting with the getting of advertising for the paper. Along toward the end of the 80's he came to New York and became advertising agent for the American edition of the *London Illustrated News*. *Cassier's Magazine* was started in November, 1891, Mr. Cassier being editor and publisher for about a year and a half, when Mr. Albert Spies assumed the editorial charge of the publication in 1893. The London edition of *Cassier's Magazine* was established in 1894, and in 1903 the Cassier's Magazine Co., which had been incorporated with Mr. Cassier as president, purchased the *Electrical Age*. Subsequently a separate concern was formed, the Electrical Age Co., with Mr. Cassier as president, to publish this journal. He was an associate member of the American Society of Mechanical Engineers, a member of the Republican Club, Automobile Club of America, Camera Club, and the Manufacturer's Club of Philadelphia. His home was at Trumbull, Conn., about three miles from Bridgeport. He was married in 1890 to Miss Agnes Nichols, but had no children.

John Saltar, Jr., president of the Otto Gas Engine Works, Philadelphia, Pa., died July 12. Mr. Saltar was a graduate of the Rensselaer Polytechnic Institute, class '67. Upon graduation he took a position as civil engineer of an eastern railroad and later was appointed city engineer of Saratoga, N. Y. Leaving this position after very satisfactory service he went with the government of Equador in charge of important work. Upon completion of this work he returned to railroad work in the United States and finally accepted a position with the North Chicago Steel Works. Leaving this position in 1881, he became manager of the Western department of the Otto Gas Engine Works, and seven years ago was elected president of the company. Mr. Saltar was the inventor of the type of gasoline engine used in submarine boats throughout the world. He was an active member of the Masonic order and of the Western Society of Mechanical Engineers. His interment took place in Rockford, Ill., the place of his birth.

Chas. E. Tripler, of liquid air fame, died June 20 at Liberty, N. Y., after an illness of several months. Mr. Tripler was born in 1849 and became famous by his production of liquid air and its commercial exploitation. The great expectations raised for liquid air failed to materialize and Mr. Tripler died a somewhat discredited man.

Rufus T. King, who at the time of his retirement in January, 1905, was said to be the oldest railroad engineer, died at Nashua, N. H., May 20. Mr. King was born in Westport, R. I., in 1832, and entered railroad service in 1847 as fireman. He became an engineer in 1849 and remained in almost continuous service until 1905.

* * *

PERSONAL.

Oscar E. Perrigo has taken charge of the shops of the Corwin Mfg. Co., Peabody, Mass.

John D. Webber has been made superintendent of the Auto Weighing Machine Co., Newark, N. J., formerly of Jersey City.

F. A. Curtiss, the Eastern advertising representative of MACHINERY sailed on the *Baltic* July 3 for a month's pleasure trip in the British Isles and on the Continent.

Ned Wheeler, formerly of the University of Kansas, will be instructor in steam engineering at the Case School of Applied Science, Cleveland, Ohio, for the coming year.

W. D. McKinnin, for the past ten years in charge of the socket department of the Morse Twist Drill Co., New Bedford, Mass., has resigned his position to accept a similar one with the Union Twist Drill Co., Athol, Mass.

J. Bertram Young has been appointed chemist of the Philadelphia & Reading Railroad Co. vice Robert Job, resigned.

Arthur L. Westcott, assistant professor in the department of mechanical engineering, Case School of Applied Science, Cleveland, Ohio, has resigned to go as assistant professor of experimental engineering with the University of Missouri, Columbia, Mo.

Fred. Perkins and A. P. Lee, of the Perkins Machine Co., Warren, Mass., will sale for Europe August 2d. They will visit England, Scotland, Ireland, Germany, Italy, France, Holland and Belgium to familiarize themselves with the European conditions in regard to presses.

Louis Buschman has been engaged as instructor in gas engineering and automobile practice for the Case School of Applied Science, Cleveland, Ohio. Mr. Buschman recently had charge of an automobile school in connection with the Central Y. M. C. A. of Cleveland.

Howard D. MacDonald, who for several years has been connected with the Deering Works, International Harvester Co., Chicago, went with the J. I. Case Threshing Machine Co., of Racine, Wis., on July 1, as chief draftsman of their tool designing department.

A. L. DeLeeuw, Hamilton, Ohio, a well-known contributor to MACHINERY now engaged in consnlting work, is at present engineering the changes and additions to the Hamilton Foundry & Machine Co. of that city. The company is doubling the capacity of its plant and at the same time installing electric drives throughout.

S. J. Berard, formerly a draftsman with the Deane Steam Pump Co., has been taking a course at the Sheffield Scientific School, Yale University, for the past two years, and has been appointed assistant instructor in descriptive geometry and machine design in this institution, the appointment to take effect this fall.

D. E. MacCarthy has been made president and treasurer of the newly organized concern, General Mfg. Co., Elkhart, Ind., manufacturers of bag-making and bag-printing machinery and builders of general machinery contract work. This concern was formerly the New National Mfg. Co. of the same place. Mr. MacCarthy learned the toolmaker's trade with the Wiley & Russell Mfg. Co., Greenfield, Mass., and afterward worked as a toolmaker in several shops, including the Springfield Armory. He then became a designer with the Westinghouse Electric & Mfg. Co., at East Pittsburg, and afterward was put in charge of the detail manufacturing department of that company. Later he became superintendent of the Burroughs Adding Machine Co., St. Louis, Mo., and assisted in the design and arrangement of their new plant at Detroit.

* * *

FRESH FROM THE PRESS.

THE INDICATOR HANDBOOK. By C. N. Pickworth. 130 pages 4¾x7¼ inches, 81 cuts. Published by Emmott & Co., Ltd., Manchester, England, and by D. Van Nostrand Co., New York. Price $1.

This is the third edition of Mr. Pickworth's practical work on the steam engine indicator, its construction and application, errors, methods of attachment, reducing gear, care of the indicator, etc. The book is one that can be recommended unhesitatingly.

POOR'S DIRECTORY OF RAILWAY OFFICIALS (Steam, Electric and Other). 244 pages, 6x9 inches. Published by Poor's Railroad Manual Co., 68 William Street, New York City.

This publication, revised and corrected to Feb. 1, 1906, is a supplement to Poor's Manual of Railroads and contains lists of the officials of all the railroads in operation in the United States, Canada and Mexico on steam, electric and other railroads. In addition are giveu statistics on steam railroads and of street railroads in which the length of railroads owned, length of railroad operated, capital stock, bonded debt, gross earnings, operating expenses, net income and payments from net income are given for each railroad company.

TRIGONOMETRY SIMPLIFIED. By Chas. Maison. 61 pages 5x7 inches, 28 diagrams. Published by the National Book Co., Cleveland, O. Price 50 cents.

The author says that his aim in preparing this work was "to furnish just so much trigonometry as is actually taught in the schools throughout the world; all investigations of importance both of practical and theoretical work are to be found included." The treatment is of a strictly practical nature and the application of the principles to common problems, many of a mechanical nature, perhaps will make the work of seemingly greater worth to some readers than would the same presentation of the principles in the usual form. The value of a working knowledge of trigonometry to the designer, draftsman and machinist cannot be gainsaid, and if the work in review will assist in overcoming the needless prejudice of many such it is to be commended.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USES IN BUILDING CONSTRUCTION. By H. H. Rice, Wm. M. Torrence and others. 122 pages 6x9 inches. Published by the Engineering Publishing Co., New York. Price $1.50.

This book is made up of articles (and abstracts of same) offered by various competitors who joined in the competition for money prizes of $250 and $100 offered jointly by the *Engineering News* and *Cement Age* of New York City. The two papers which won the prizes are printed in full and the abstracts are parts of ten papers not awarded prizes but which contained data not in the prize papers or which presented the same information in greater length. The articles review the patent situation, the construction of molds, forms of blocks, the relative merits of "wet" and "dry" concrete mixtures, methods of mixing, waterproofing, curing, etc., and a very complete essay on the "state of the art" at the present time. A list of concerns making concrete block machinery is given in an appendix. The growing importance of concrete construction makes the subject of concrete blocks and their use in building construction of great general interest. There is little doubt that the use of concrete in both monolithic and block form will largely displace all other materials of construction within a few years. The scarcity of lumber and its increasing price will virtually force the substitution of other materials, and concrete offers the most practical and the cheapest substitute known. Being fireproof and largely composed of materials found in most localities its use for general building purposes will result in greatly increased permanency of construction and freedom from the destructive fires which is such a standing serious menace to most American cities and towns.

NEW TRADE LITERATURE.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa., 6 x 9 pamphlet, Record of Recent Construction, No. 56, describing the locomotives of the Atchison, Topeka & Santa Fe Railroad System.

ATHOL MACHINE CO., Athol, Mass. New catalogue No. 30 of Vises, Grindstone Frames, Machinists' Tools and other specialties made by the company. The book shows cuts of the various tools and gives tables of specifications, including price lists, for each.

THE INGERSOLL-RAND CO., 11 Broadway, New York City. Catalogue No. 383 of the Temple-Ingersoll Electric-Air Rock Drill. Some new features, construction details, and distinctive features of operation are given as well as descriptions of the tool and its mountings.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. 6 x 9 pamphlet, Record of Recent Construction No. 57, describing the locomotive equipment of the "Associated Lines." The Associated Lines comprise the Southern Pacific, Uniou Pacific, Oregon Short Line, Oregon Railroad & Navigation Co., and the Chicago & Alton Railways.

THE LUMEN BEARING CO., Toronto, Can., have issued a pamphlet called *The Lumenary*, which they expect to publish monthly. A special feature is the metal report which is a table giving an accurate review of the prices of non-ferrous metals, quotations being taken from the New York daily metal reports.

THE NILES-BEMENT-POND CO., 111 Broadway, New York City, have compiled a list, No. 12, of second-hand metal working machinery. This list groups the various kinds of machinery, *e. g.*, railroad machinery, lathes, drills, etc., and gives a brief paragraph of description of the various types in each.

THE BILLINGS & SPENCER CO., Hartford, Conn. Catalogue of Improved Drop Hammers. Specifications for the hammers are given and various of the parts are shown and described in detail. This firm manufacture a complete line of drop-forged machinists' tools, a catalogue of which will be sent upon request.

LANDIS TOOL CO., Waynesboro, Pa. Catalogue of Landis Grinders. The object of the catalogue is to assist those who are not familiar with grinding machines to understand them and properly care for them. With this in view, the use and operation of the machines are explained aud a clear description of the various types is given.

WINDSOR MACHINE CO., Windsor, Vt. Catalogue treating of the Gridley automatic turret lathe. It points out the merits of this machine and its special advantages over other turret machines. A general description of the machine is given and many excellent engravings illustrate the lathe and its various parts, as well as work produced by it.

THE COLBURN MACHINE TOOL CO., Franklin, Pa., have issued an attractive catalogue B concerning the Colburn Universal Saw Table. The words on the front of the cover, "Built Like a Machine Tool," give an idea of the general character of the machine. Complete specifications for all the parts of the machine are given and the book is well illustrated with half-tone engravings throughout.

THE E. W. BLISS CO., 5 Adams Street, Brooklyn, N. Y., have issued a catalogue on "Bliss" machinery for manufacturing electrical parts. The book shows various types of presses, the armature disk-cutting press, the double crank press, the automatic armature disk-notching press, etc., and illustrates on page 52 sheet metal electric parts produced by "Bliss" machinery.

THE GLOBE MACHINE & STAMPING CO., Cleveland, O., are issuing a monthly pamphlet entitled *The Silent Partner*, which is designed to be a medium for taking their patrons and prospective patrons into their business confidence. It contains information concerning the prouct, plant, etc., of the company. They have also issued a pamphlet entitled, "Do You Tumble?" It contains descriptions and illustrations of horizontal tumblers not hitherto announced.

GISHOLT MACHINE CO., Madison, Wis. Leaflet announcing the purchase of the plant and patents of the American Turret Lathe Co., Warren, Pa., which was effected several months ago. The Warren plant will be used essentially as a manufacturing shop, and all special tools will be built at the Madison plant, where the general offices of the company will be continued. The leaflet gives a brief description of the Warren plant which is one well adapted for manufacturing machine tools. A description of this interesting machine tool shop appeared in the June, 1903, issue of MACHINERY.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin 66 describing class W direct current motors for rolling mill service. These motors are built only for one speed and 220 volts, either series or compound wound, and in four sizes: 25, 50, 75 and 100 horsepower. They are of the inclosed type, and while intended primarily for rolling mill service, are well adapted for any service where a motor is required for heavy intermittent work of a jerky nature. The suggestions of the best mill engineers throughout the country were invited, and utilized in its design. Bulletin No. 67 describes Form 1-F variable speed motors and shows a number of machines driven by same.

MANUFACTURERS' NOTES.

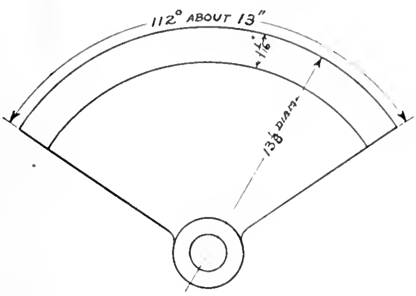
THE CROCKER-WHEELER CO., Ampere, N. J., have sold the Pusey & Jones Co., Wilmington, Del., 33 motors ranging from 1 to 25 H. P. for driving their various ship-building machinery.

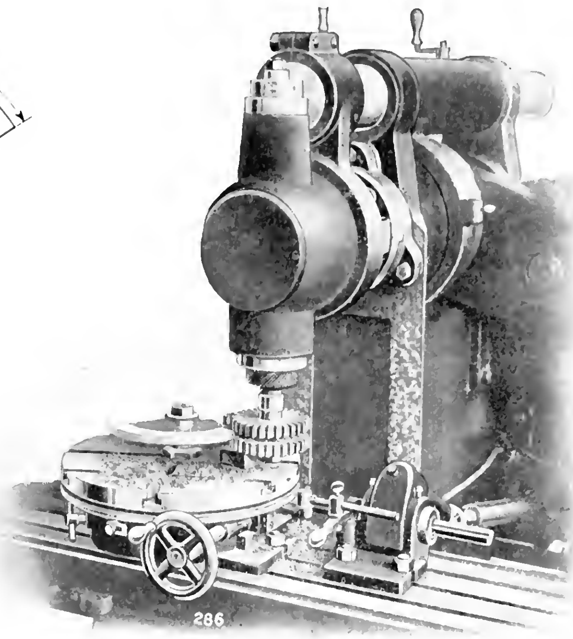
THE TRENTON MALLEABLE IRON CO., Trenton, N. J., have entered into the manufacture of gas engines and suction gas producers; the sizes to be built at present are from 30 to 150 H. P., inclusive. Mr. William R. Huttinger is the designer and engineer, and Mr. Frank Peterson is in charge of the sales department.

THE BROWN & SHARPE MFG. CO., Providence, R. I., announce that their works will be closed from August 3 to 13 inclusive for the annual vacation and repairs. The offices will remain open as usual, however, and orders for machine tools, machinists' tools and measuring tools will receive the same attention as at other periods of the year.

THE SPRAGUE ELECTRIC COMPANY announce that it has reopened its office in San Francisco. The former office was destroyed by the earth-

Milling Lathe Work?





Material: Gray Iron 13⅛" dia., 7-16" thick.

Cut: 1-16" deep.

Cutters: 2" and 6" diameter.

R. P. M.: 45.

Why not, when it saves costs? Of course, it may not pay to put a machine in solely for these odd jobs, but when you can get a standard machine that is at once a horizontal spindle miller, a vertical spindle miller and a circular miller, you have an outfit that will do cheaply and accurately a lot of work on which you are now spending too much time. The illustration shows a

No. 3 Plain Cincinnati Miller

fitted with a Vertical and Circular Attachment, finishing three sides of the pieces shown in the sketch, at one cut in 11½ minutes each, including chucking. This same machine will cut your planer and shaper costs in half.

Get our estimates and suggestions on milling your work,
WE ARE MILLING SPECIALISTS.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. *Canadian Agents*—Williams & Wilson, Montreal. H. W. Petrie, Toronto.

CONTENTS FOR AUGUST.

quake, after which temporary quarters were opened in Oakland. The company is permanently located in the Atlas Building on Mission Street, San Francisco, Cal., where all orders from that territory will receive prompt attention.

At the election of new officers of the Newton Machine Tool Works, occasioned by the death of Mr. Charles C. Newton, the founder and president of the company, Harry W. Champion was made president; Wm. M. Graham, treasurer; and Ellis J. Hannum, secretary. All these officers have been closely associated in executive positions for many years and no change will be made in the conduct of the business.

The plant of the Dayton Pneumatic Tool Co., Dayton, Ohio, was damaged by fire July 2d, but we are advised that the injury was comparatively slight, being confined to belting, line-shafting, miscellaneous office supplies, etc. The damage to the power plant made it necessary to close down for a few days until the power plant could be repaired. Operations were to be resumed with full force July 6.

The Toledo Machine & Tool Co., Toledo, O., have secured an order from the United States Government for several presses for one of the navy yards. They have also booked an order for a drop forging plant consisting of one 3,500-pound, two 2,500-pound, two 2,000-pound, two 1,500-pound, and two 1,000-pound drop hammers, and eleven trimming presses ranging in weight from 8,000 to 27,000 pounds.

The Niles-Bement-Pond Company and Pratt & Whitney Company have removed their Boston offices from Pearl Street to more spacious and handsomely furnished quarters on the eight floor of the Oliver Building, corner of Milk and Oliver Streets. The policy of these companies is to dispense with showrooms, the variety of both heavy and light machine tools and cranes built by their several works being too great to permit of exhibition.

The Foos Gas Engine Company, Springfield, Ohio, who have been buying considerable machinery within the last year have again placed an order for $20,000 worth of machine tools, consisting of lathes, planers, boring mills, drill presses, grinders, etc. They find that their present equipment is inadequate to meet the increasing demand for their engines. They have the largest exclusive gas engine factory in the world, having built strictly high grade engines since 1887. They are employing twice as many men in their shops at the present time as they did two years ago.

MISCELLANEOUS.

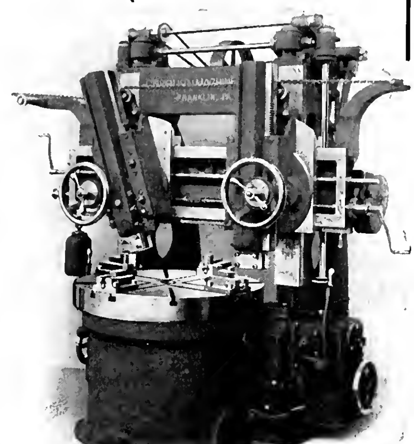
Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

COLBURN ECONOMY

is another name for Colburn Boring and Turning Mills. Nearly every shop has a great variety of work which is being done and done very well, as far as quality is concerned, on other machines but which should go on a

COLBURN MILL

to get the time and thus the cost down to bed rock where it belongs.

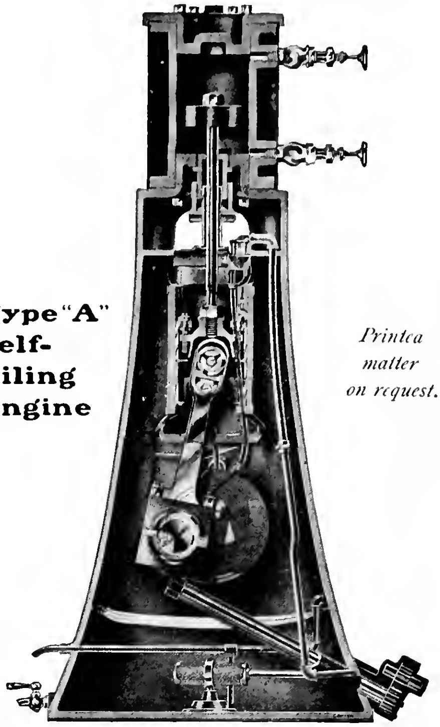


Powerful drives, massive heads, rapid traverse for heads, safety device for protection of gears, brakes, etc., aid in accomplishing this.

Write for descriptive bulletin.

SIZES
30" to 72"

Colburn Machine Tool Co., FRANKLIN, PA. U. S. A.

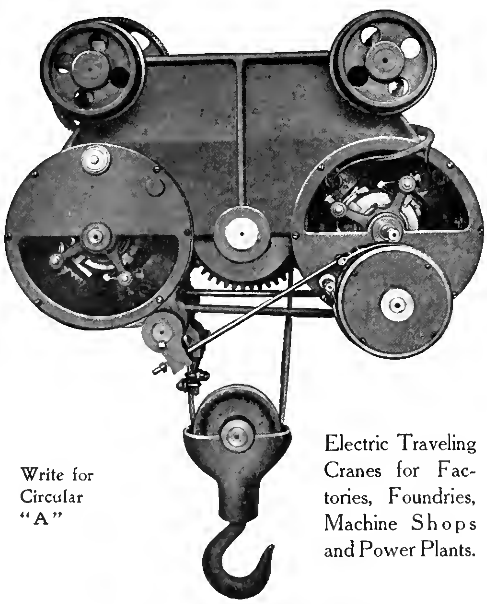


Type "A" Self-Oiling Engine

Printed matter on request.

American Blower Co., Detroit.

Electric Traveling Hoists



Write for Circular "A"

Electric Traveling Cranes for Factories, Foundries, Machine Shops and Power Plants.

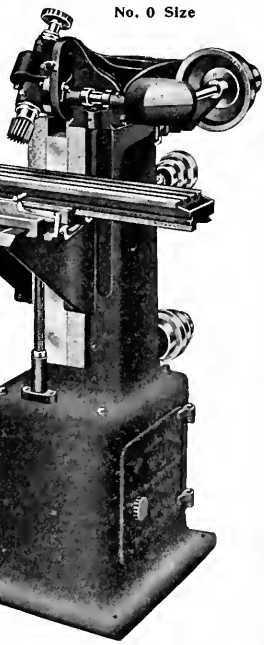
Detroit Engineering Works,
183 Larned St., W., DETROIT, MICH.

Right Angle End Mills will cut **all angles** on a

VAN NORMAN

"DUPLEX" Milling Machine

No. 0 Size



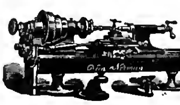
Cutter spindle operates in either vertical or horizontal position and at any angle.

Position of head and ram can be changed in a moment, saving a large amount in cutters and fixtures.

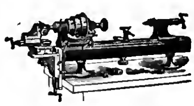
The No. 0 size is a time and money saver on tool room, jig, fixture, gauge and experimental work.

Let us tell you about other good points.

Waltham Watch Tool Company
Springfield, Mass., U. S. A.



No. 5 Bench Lathe
is a good companion, taking the same split chucks as the Van Norman "Duplex" Milling Machines.

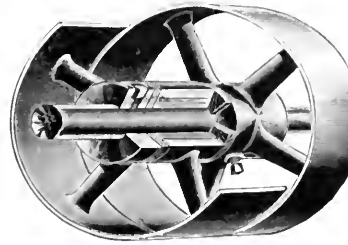


"Every Little Helps"

But Some Little Things Help More than a Little

"Arguto"

TRADE MARK
"Reg. U. S. Pat. Of."



Loose Pulley Equipment

Arguto Oilless Bearings are not very large but they do more good to the square inch in their own field of usefulness than anything you can mention.

The loose pulleys and friction clutches fitted with Arguto Bearings run smoothly, quietly and continuously without any attention. Why? Because "Arguto" cuts out the lubrication problem. Oil and rapid running pulleys never stay long in company—and trouble follows the parting. With Arguto Bearings there is no further need of oil or oiling, there are no spattered walls or floors, no lost time. They prolong the life of your belts from 40 to 50 per cent., save labor, trouble and wear indefinitely. *6 to 8 years, without being oiled—where heretofore the Pulleys required attention every 6 to 8 hours—is an item.* If interested, send for catalogue and testimonials.

Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, Pa.

Four very good reasons why you should install a Gear Shaper

FIRST—It will cut 25 to 50 per cent. more gears than any other machine.

(How long would it require to pay for a machine at that rate? Is it important that you get out more work in these busy times?)

SECOND—It will cut smoother running gears than any other machine, because the cutter is not only theoretically correct, but all distortion is ground away after it is hardened.

(Absence of noise and minimum of power are important features in gearing.)

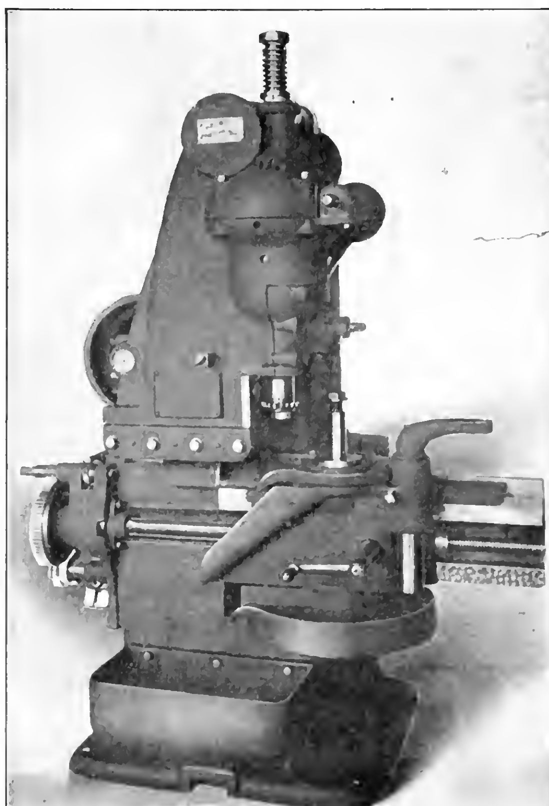
THIRD—It handles to advantage a large variety of work not possible, or at least not practicable, on any other machine.

(This is because of the planing cutter, which makes it possible to plane up to a shoulder or into a narrow recess, cluster and internal gears being examples.)

FOURTH—It is durable under the most exacting conditions; simple, being the nearest to an automatic machine of any gear cutter, and thoroughly practicable in every detail.

Scores of pleased customers testify to the above. Ask for a list of unprejudiced users, and send prints for cutting time.

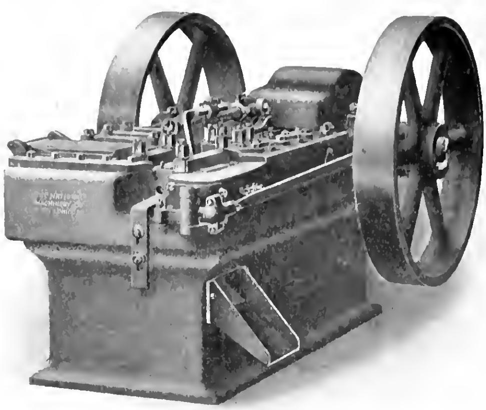
Remember our gear cutting department.



The Fellows Gear Shaper Co.

25 Pearl Street, SPRINGFIELD, VT., U. S. A.

FOREIGN AGENTS—Henry Kelley & Co., Manchester, England. M. Koyemann, Dusseldorf, Germany. Ph. Bonvillain and E. Ronceray, Paris, France. White, Child & Beney, Vienna, Austria. Walter S. Stone & Co., Yokohama, Japan. The C. & J. W. Gardner Co., St. Petersburg, Russia.



The National Rivet and Track Bolt Header

A gripping action that positively will not allow the grip dies to "give" during the upset.

A gripping action that obviates the necessity of setting dies to "overgrip" to secure the desired pressure on work.

A relief action that fully protects the machine and yet cannot operate at that time when it is important that a relief *should not* operate, i.e.—while head is being made.

A completeness of design and a standard of material and workmanship not to be found elsewhere in such equipment.

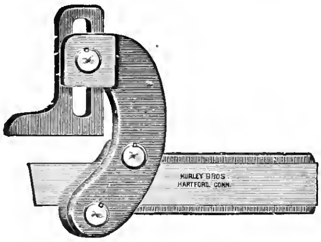
This new tool bids fair to soon become the standard rivet header.

ALSO
Bolt Heading Machines
Forging Machines
Bolt Cutters (25 sizes and styles)
Hot Pressed Nut Machines
Nut Tappers
Washer Machines
Bulldozers
Wire Nail Machines

THE NATIONAL MACHINERY CO
TIFFIN, OHIO, U.S.A.

FOREIGN AGENTS:
Fenwick, Freres & Co., Paris, Brussels, Liege.
Buck & Hickman, Ltd., London, Birmingham, Manchester, Glasgow.
De Fries & Co., Berlin, Dusseldorf.
Takata & Co., Tokio.

H. B. Pat. Cutting-off Tool.

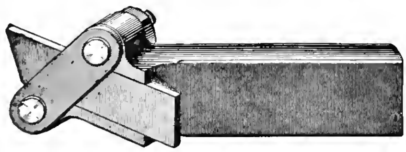


Something New and Good.

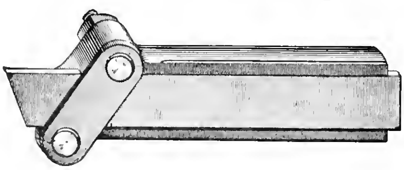
Brass or Steel foot rests. Uses regular Slate Blades. Shank same as Slate No. 2.

Slate No. 2 Offset Cutting-off Tool.

Shank $1\frac{1}{8}$x$\frac{1}{2}$".



Slate No. 2 Cutting-off Tool.



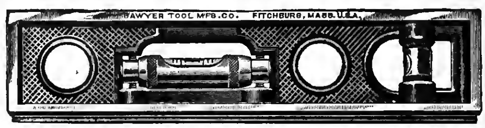
Shank $1\frac{1}{8}$x$\frac{1}{2}$". Blades $\frac{1}{16}$ to $\frac{1}{4}$" by 16ths. Special sizes by 1000ths made to order.

Also **Crescent Cutting-off Tools.** Straight shanks, no projections, for screw machine use. No. 2, $1\frac{1}{4}$x$\frac{1}{2}$". No. 3, $1\frac{7}{16}$x$\frac{5}{8}$" shank. No. 2 blades $\frac{7}{8}$" wide. No. 3, 1" wide, all thicknesses. For sale by supply dealers, or

Dwight Slate Machine Company
HARTFORD, CONN.

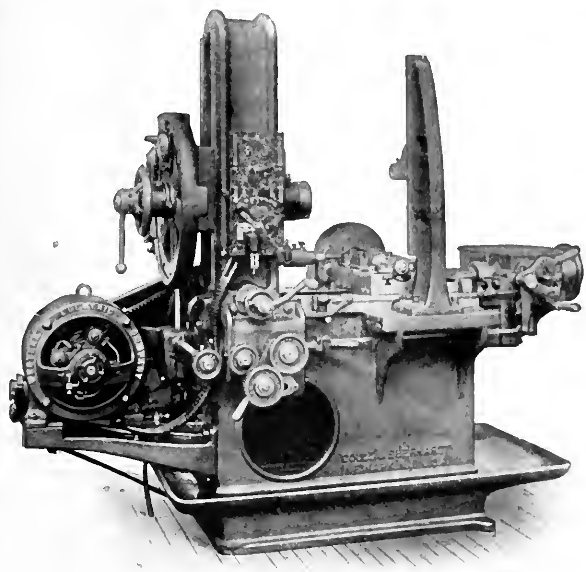
New No. 7 Sawyer Level

with patent ground glasses!



Simple and positive adjustments. Nicely finished. Made to satisfy the requirements of the most exacting mechanics in all lines of mechanical work. A very high grade level at a moderate cost. Our catalogue gives further description. Also shows our complete line. Send for it.

Sawyer Tool Mfg. Co.
71 Winter St., Fitchburg, Mass.



Peculiarities of Machine Tools

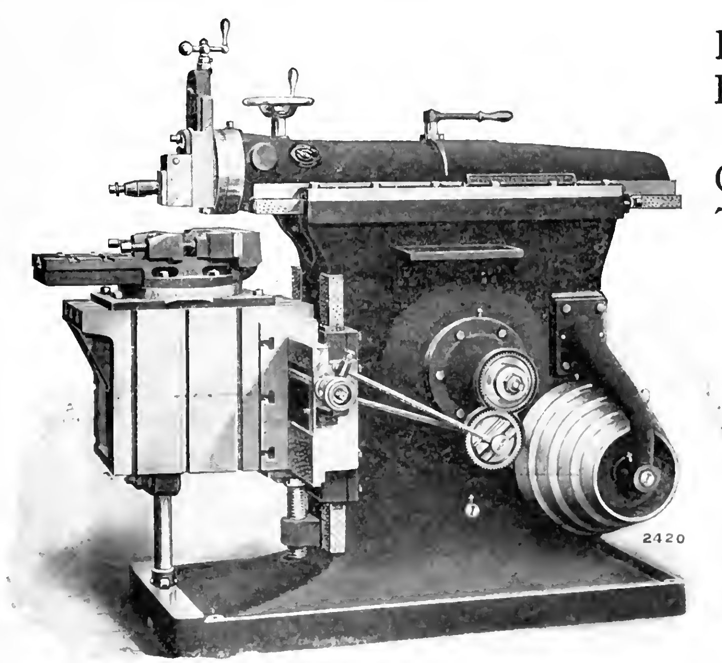
require that motors for their operation, be designed for that purpose. Our type "E" motor, which has operated so successfully, will withstand wide variations of load without sparking or overheating. The motor permits of heavy overloads without injury.

Write our nearest house for a copy of Bulletin 12-D.

Western Electric Company

Chicago New York Saint Paul Philadelphia
Saint Louis San Francisco Cincinnati
Denver Kansas City Pittsburg Los Angeles Seattle

HEAVY DUTY SHAPERS



24-inch Back Geared Crank Shaper.

Plain Crank Shapers
Back Geared Crank Shapers
Geared Rack Shapers
Traverse Shapers

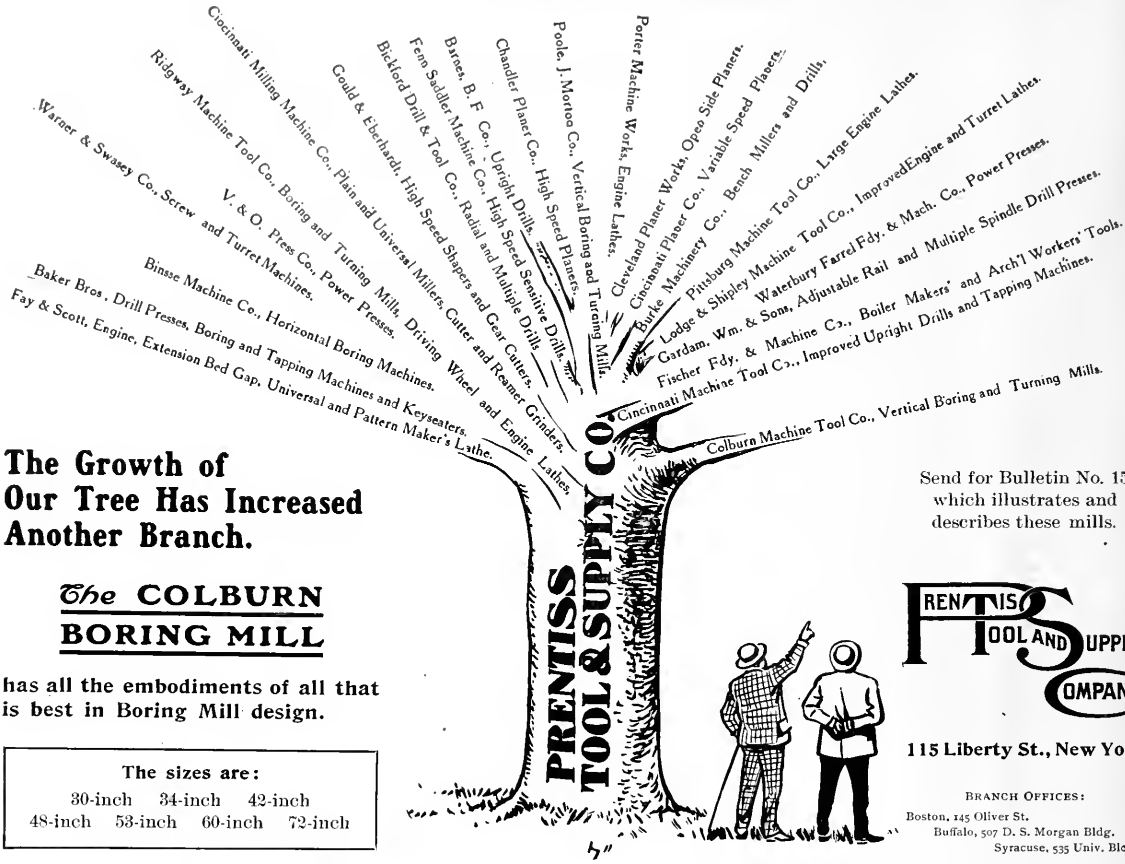
CATALOGUE ON REQUEST

The Cincinnati Shaper Company

Garrard Ave. and Elam St.
CINCINNATI, OHIO

The Largest Exclusive Manufacturers of Shapers

AGENTS: Manning, Maxwell & Moore, Inc., New York, Chicago, Boston, St. Louis, Cleveland; Brown & Zortman Mchy. Co., Pittsburg; W. H. Shipley, Philadelphia; The National Supply Co., Toledo, O.; C. W. Burton, Griffiths & Co., London; A. H. Schutte, Brussels, Cologne, Liege, Milan, Bilbao, Paris; Schuchardt & Schutte, St. Petersburg, Vienna, Berlin, Stockholm; H. W. Petrie, Toronto.



The Growth of Our Tree Has Increased Another Branch.

The COLBURN BORING MILL

has all the embodiments of all that is best in Boring Mill design.

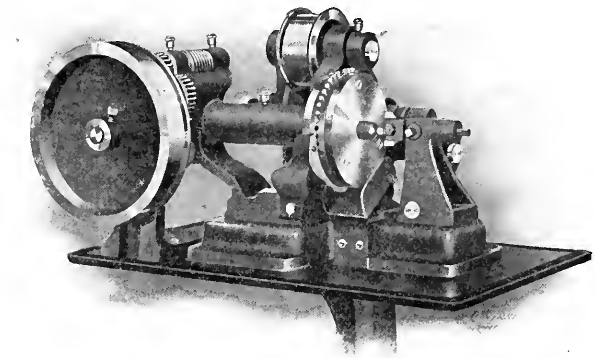
The sizes are:			
30-inch	34-inch	42-inch	
48-inch	53-inch	60-inch	72-inch

Send for Bulletin No. 15 which illustrates and describes these mills.

PRENTISS TOOL AND SUPPLY COMPANY

115 Liberty St., New York

BRANCH OFFICES:
Boston, 145 Oliver St.
Buffalo, 507 D. S. Morgan Bldg.
Syracuse, 535 Univ. Block.



THE "ACME"

Semi-Automatic Screw Slotting Machine

is the most successful and economical for slotting headless, shoulder, hexagon, square, flat, round and special head screws, also irregular shapes within its capacity.

Speed limit is cutting capacity of the saw. Interchangeable discs for various sizes of screws.

SHIPMENT FROM STOCK

THE NATIONAL-ACME MFG. CO.
CLEVELAND, OHIO, U. S. A.

Branch Offices: NEW YORK BOSTON CHICAGO
Foreign Representatives: Schuchardt & Schutte. Alfred H. Schutte.

Are You Having Trouble in your drilling department? If so write us about it, perhaps we can help you.

Drills, Reamers, Chucks.

A trial order will convince you of the superiority of National Drills.

Special Tools.

Our improved method of tempering produces a tool of the first quality.

MANUFACTURED BY
The National Twist Drill & Tool Co.
DETROIT, MICH.

GENERAL SALES AGENTS
The Whitaker Manufacturing Co.
CHICAGO, ILL.

"CLEVELAND" OPEN SIDE PLANER

Simplicity in construction is the aim of all good tool builders. The "Cleveland" is simplicity itself, and with this is coupled stiffness and rigidity, three essentials for a long lived tool. It does the work, it is accurate.

One user says in a letter just received:

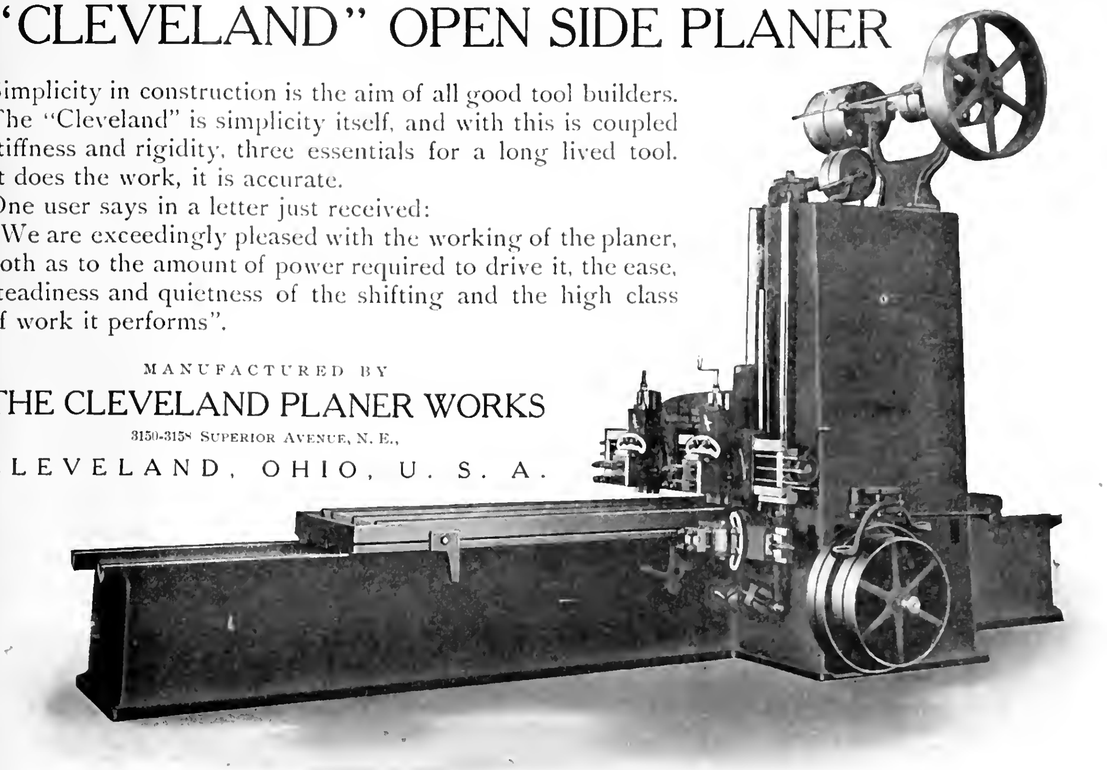
"We are exceedingly pleased with the working of the planer, both as to the amount of power required to drive it, the ease, steadiness and quietness of the shifting and the high class of work it performs".

MANUFACTURED BY

THE CLEVELAND PLANER WORKS

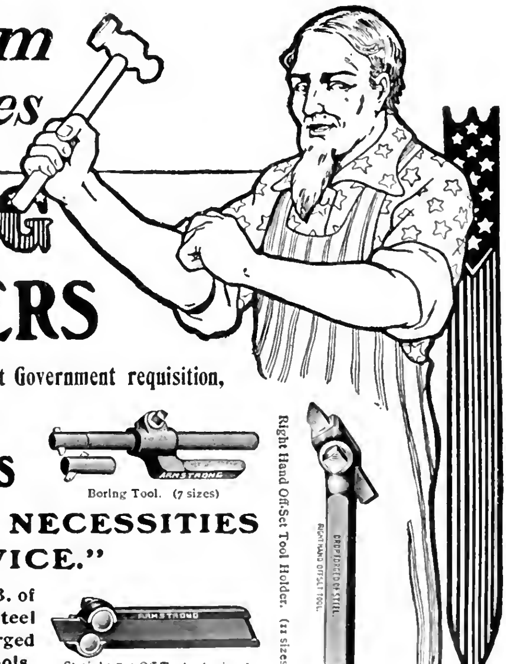
3150-3158 SUPERIOR AVENUE, N. E.,

CLEVELAND, OHIO, U. S. A.



This machine is 48"x48"x16'. Made in all sizes from 30" to 72" in width and any length.

Uncle Sam Specifies the ARMSTRONG TOOL HOLDERS



Because, to quote the exact words of a recent Government requisition,

"NO OTHERS WILL ANSWER THE NECESSITIES OF THE SERVICE."

Left Hand Off-Set Tool Holder. (11 sizes)

Straight Tool Holder. (11 sizes)

Boring Tool. (7 sizes)

Right Hand Off-Set Tool Holder. (11 sizes)

Planer Tool. (7 sizes)

They make ONE LB. of High Speed Tool Steel worth 10 lbs. in forged Lathe and Planer Tools.

Straight Cut-Off Tool. (7 sizes)

Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, U.S.A.

"The Tool Holder People"

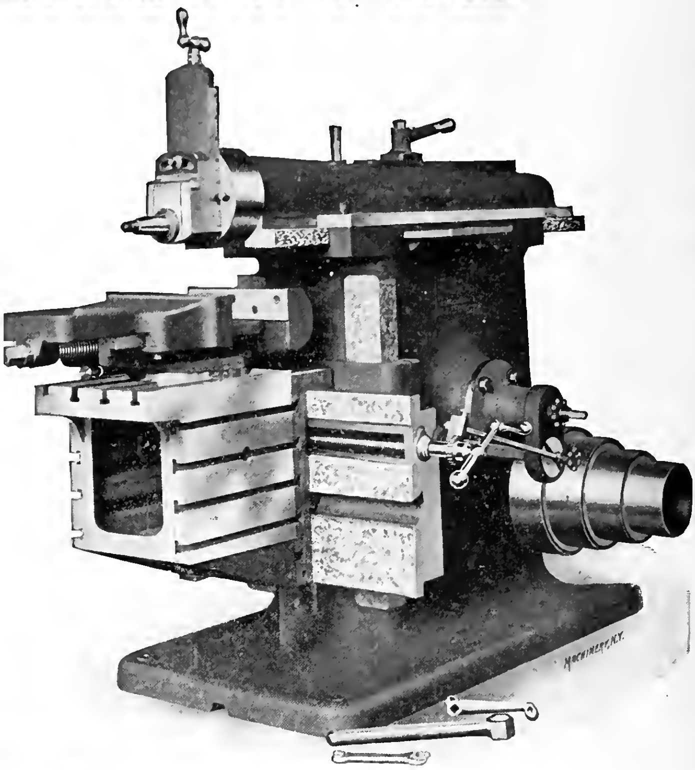
Imitations are Unsatisfactory Infringements are Unlawful

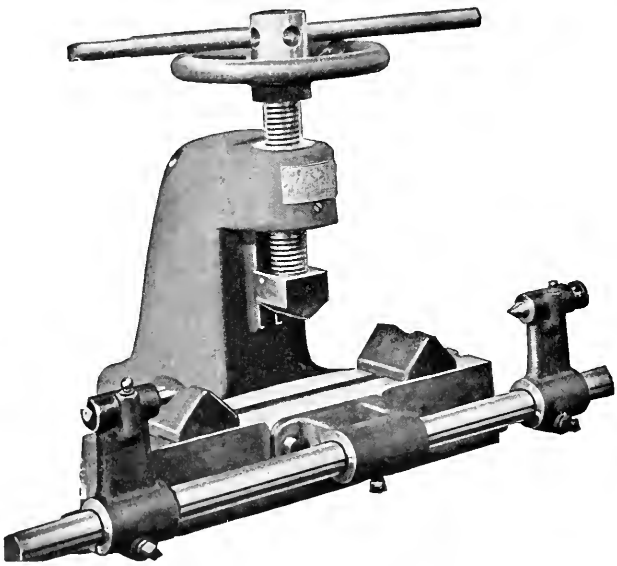
WRITE FOR CATALOG

SPRINGFIELD COST REDUCERS

There isn't a Shop that can do without a good Shaper—

It is an every-day need, an all day need, we might say, and there is no better shaper made than the Springfield 25-inch Back Geared Crank Shaper. Look it over—note the extra large bearing surfaces, the heavy, deeply ribbed column, the massive cross-rail, the special construction that makes a table support *superfluous*. The actual stroke of this machine is 26½ inches, the net weight is 4,600 pounds, and we shall be glad to quote price on demand.





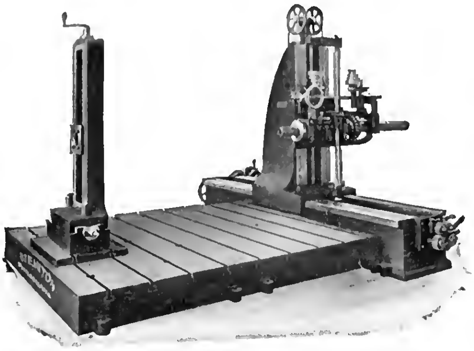
There isn't a Tool Room but has use for this Bench Straightening Press

The size shown is the No. O Press with power enough to bend a shaft 2½ inches in diameter, or its equivalent in other shape. It can be used for centering work in the rough or for straightening pieces accidentally sprung in use or tempering. Easily adjusted. Made in two sizes.

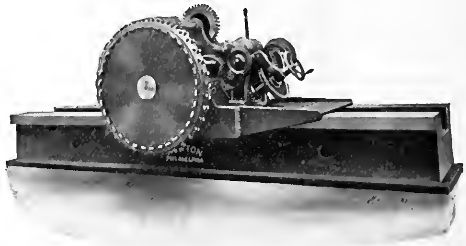
Our Catalogue shows full line of Machine Tools.

The Springfield Machine Tool Co., SPRINGFIELD, OHIO, U. S. A.

Agents for Italy, Ing. Vaghi, Accornero & Co., Milan.

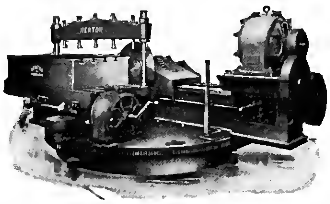


HORIZONTAL FLOOR BORING MACHINE.

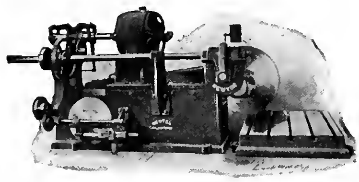


84-IN. PORTABLE ROTARY PLANING MACHINE.

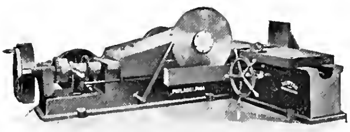
NEWTON



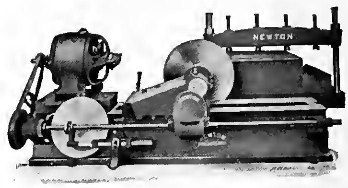
COMBINATION COLD SAW CUTTING-OFF MACHINE.
MOUNTED ON ROUND BASE.



STEEL FOUNDRY COLD SAW CUTTING-OFF MACHINE.



CRANK COLD SAW CUTTING-OFF MACHINE.



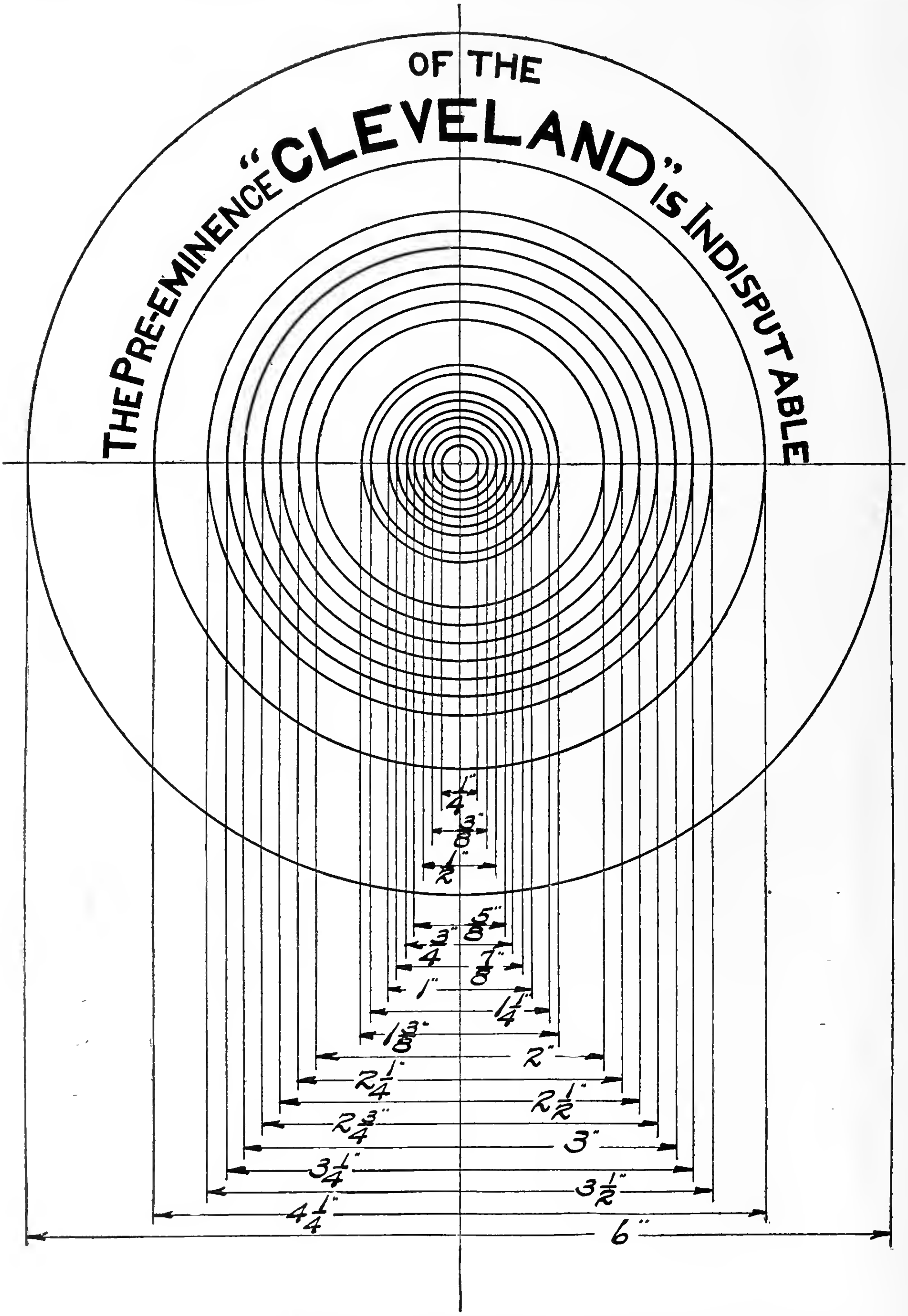
COMBINATION COLD SAW CUTTING-OFF MACHINE.

Milling Machines,
Boring and Drilling Machines,
Fixed and Portable Slotting Machines.

Railway and General Machine Shop Equipment.

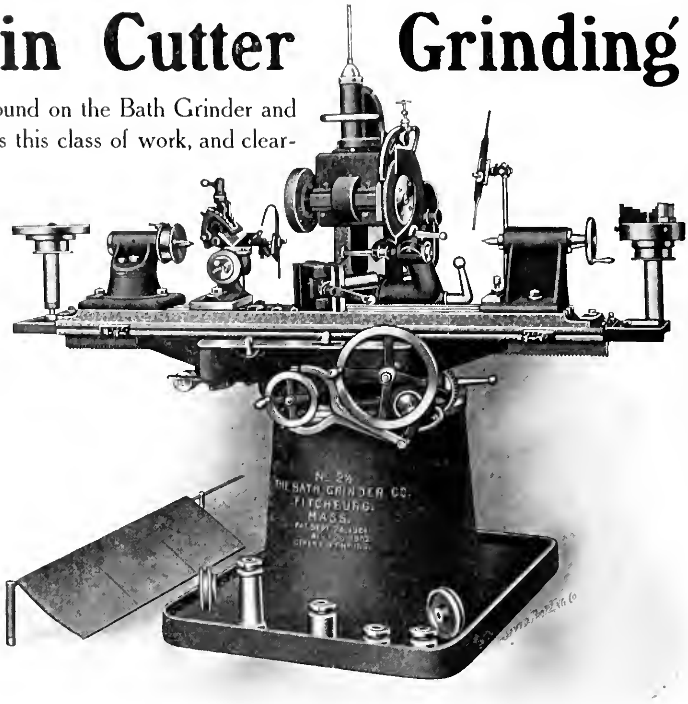
Newton Machine Tool Works, Inc.

Philadelphia, U. S. A.


THE PRE-EMINENCE OF THE "CLEVELAND" IS INDISPUTABLE
1/4"
3/8"
1/2"
5/8"
3/4"
7/8"
1"
1 1/4"
1 3/8"
2"
2 1/4"
2 1/2"
2 3/4"
3"
3 1/4"
3 1/2"
4 1/4"
6"

We Excel in Cutter Grinding

Every variety of cutter can be ground on the Bath Grinder and ground right. A cup wheel facilitates this class of work, and clearances are measured on the machine.



The Bath Universal Grinder

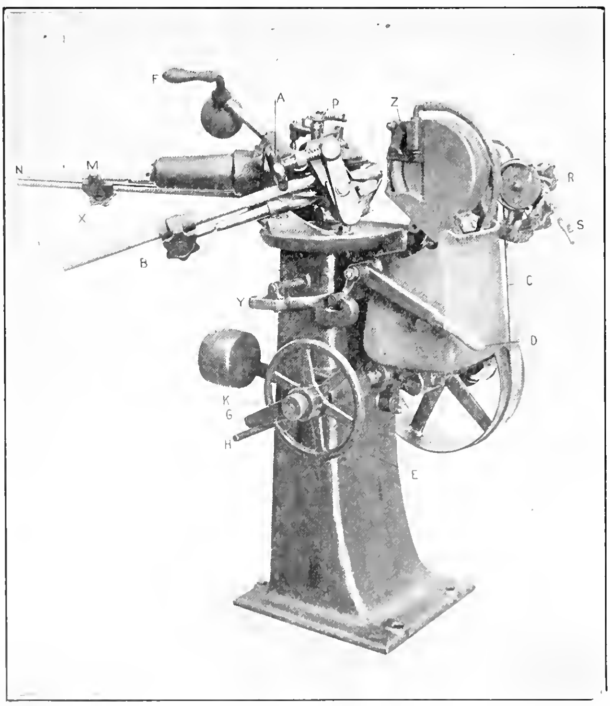
Covers the whole field of grinding. It is equipped for wet or dry grinding; has power feed and fine screw attachment to wheel for surface grinding; and an attachment for internal grinding clamps to the front of the machine. Very high speed can be attained with the latter attachment, and for internal deep hole grinding Bath machines stand pre-eminent.

These grinders are very substantial and rigid and have every provision for convenient operation.

Our catalogue shows work and wheel in positions no other grinder can give—shall we mail you a copy?

BATH GRINDER COMPANY, - Fitchburg, Mass., U. S. A.

William Sellers & Co., Incorp. Philadelphia, Pa.



Modern Machine Tools

Our Patent Improved Drill Grinding Machine with Pointing Attachment, shown in the cut, is capable for all sizes of drills from 1-16″ to 3″ diameter inclusive.

Drills ground and pointed by it last longer and do much more work before regrinding is necessary, require less power of feed and cut faster than when ground in any other way.

The machine while accomplishing remarkable results, is extremely simple and does not require a skilled workman to handle it, as nothing is left to the judgment of the operator.

All parts are interchangeable, and wear of parts does not cause lost motion.

Our new illustrated descriptive catalogue is now ready. Shall we send you a copy?

The B. & C. Friction Clutches

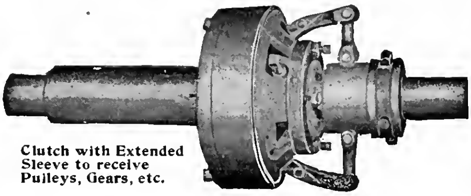
Have Powerful Grip, Positive Release and are very Easily Adjusted.

These Clutches are adapted for use with wood split pulleys, steel or iron pulleys, sprockets, gears, hoisting drums, etc., have very few parts, all friction surfaces protected from dust and grit, and will give long and efficient service.

There is also a special B. & C. Clutch for Gas and Oil Engines.

Full description and prices on request.

Clutch with Wood Split Pulley attached.



Clutch with Extended Sleeve to receive Pulleys, Gears, etc.

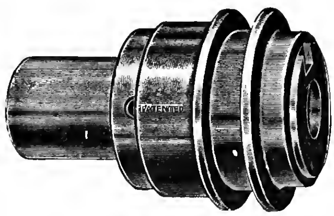
Any kind of a pulley can be used with a B. & C. Clutch - no bother or expense for special pulleys entailed—and in adjusting no arm fastenings are necessary, the pulley, gear or other device is simply clamped on the extended sleeve, and can be changed without disturbing the clutch.

Patterson, Gottfried & Hunter, Ltd., 146-150 Centre St., (Cor. Walker) **New York City**

Machinery, Metals, Hardware Tools and Supplies.

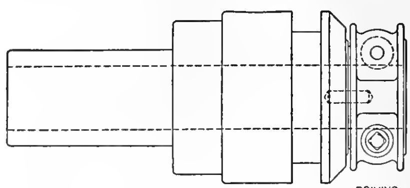
THE JOHNSON FRICTION CLUTCH

is very compact in form, smooth and highly finished. It has very few parts—and those interchangeable; has no protruding nuts or screws, runs without vibration, runs perfectly at any speed, and can be adjusted to any tension by a single screw.



For Line Shafts

this clutch will be found particularly advantageous. It can be used for running a group of machines direct from the line shaft instead of providing a countershaft for each machine. The saving thus effected in pulleys, power, countershafts, belts, etc., is a very considerable item and will go a long way towards paying for the equipment. A feature of the clutch for line shafts is the new Driving Collar, which is doweled to the clutch body and fastens to the shaft by two binder bushings, obviating the necessity of cutting keyways in the shaft and permitting the clutch to be moved to any point desired.

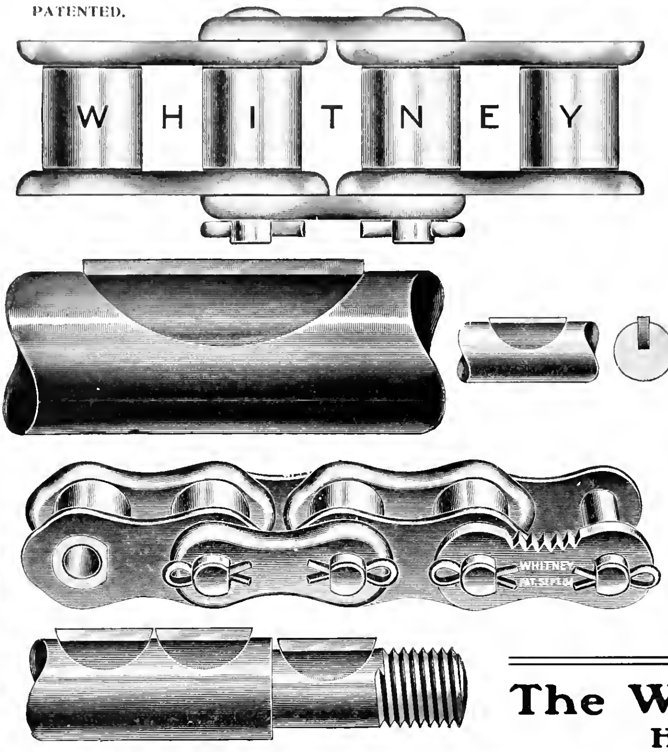


Clutch made Single or Double. Write for catalogue.

The Canadian Fairbanks Co., Agents for Canada—Montreal, Toronto, Winnipeg, Vancouver. The Efandem Co., 67 Shaftsbury Ave., London, Eng.

THE CARLYLE JOHNSON MACHINE CO. HARTFORD, CONN.

PATENTED.



"WHITNEY" CHAINS

and the WOODRUFF PATENT SYSTEM of KEYING have been adopted by the leading manufacturers of motor cars.
The Woodruff System is more mechanical, more efficient and a great labor saving invention.

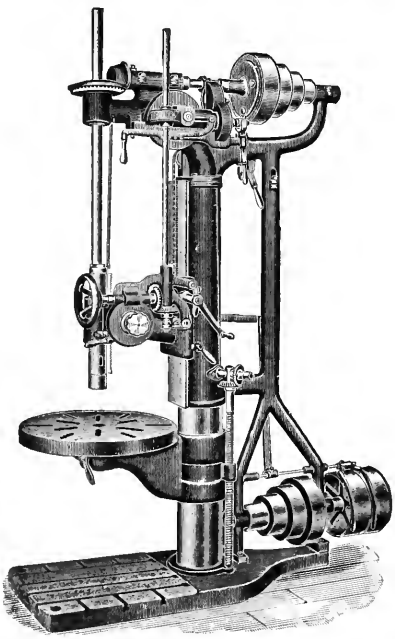
Against claims made by Competitors, we submit the following list of Motor Car Manufacturers using **"WHITNEY" ROLLER CHAINS** and **STANDARDS.** Is it not time for everyone to admit that **"WHITNEY" STANDARDS** for **ROLLER CHAIN** dimensions are now the American Standards?

"Adams-Farwell," "American Motor Truck," "Auto-Car Equipment," "Baker," "Berkshire," "Biddle-Murray," "Cadillac," "Columbia," "Champion (McCrea)," "Crown," "Crawford," "Columbus Buggy Co.," "Elwell-Parker," "Ford," "Franklin," "Gaeth," "Gale," "Grout," "Hewitt," "The Holmes," "Iroquois Iron Works," "Knox," "Lambert," "Matheson," "Mack Brothers," "Mitchell," "Moline," "New York Motor Truck," "Olds," "Packard," "Rambler," "Rapid," "Reo," "Stearns," "Thomas," "Tourist," "Vehicle Equipment," "Wayne," "Western Motor Truck," "Windsor," etc.

The Whitney Mfg. Co.
Hartford, Conn.

TRADE W.F. AND J.Co. MARK

"ORIGINAL BARNES"



Positive Feed Drills

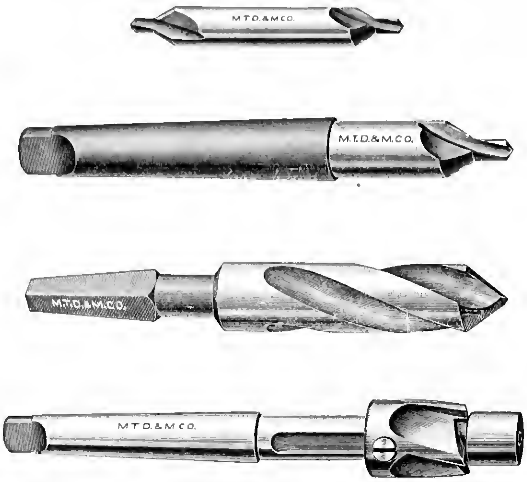
8-inch to 50-inch Swing

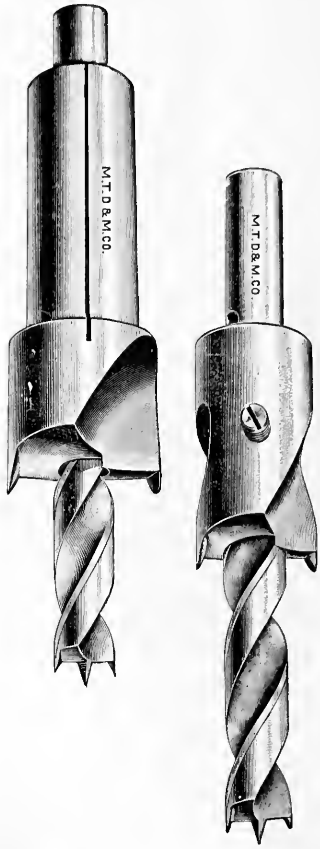
CONSIDER THESE ADVANTAGES:

1st. Absolutely positive action.
2d. Eight (8) changes of feed.
3d. No belts to throw off or on.
4th. Feed changes can be made while machine is running.
5th. Capacity of drill increased 15 to 25 per cent.
6th. Adapted for use of high-speed cutting steels.

Send for Drill Catalogue.

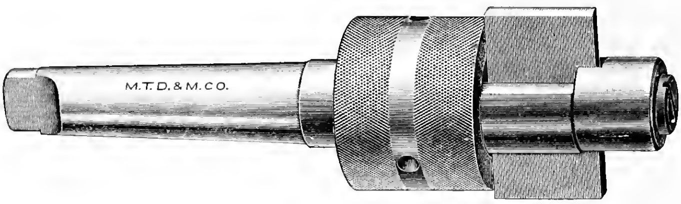
W. F. & John Barnes Co.
231 Ruby Street, Rockford, Illinois





"MORSE"

COUNTERBORES and COUNTERSINKS

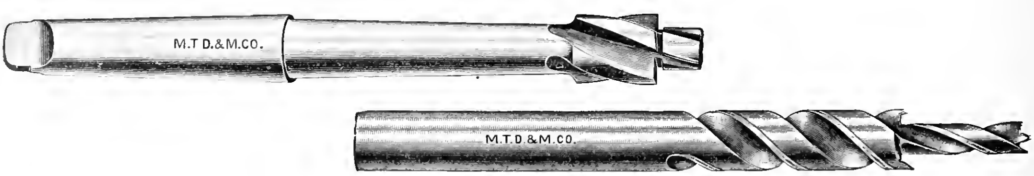


Drills with Increase Twist. Drills with Parallel Web. Drills with Constant Angle.
Drills of High Speed Steel, (our own special brand.)

REAMERS, CHUCKS, MILLING CUTTERS, TAPS, DIES, MACHINES AND MACHINISTS' TOOLS.

MORSE TWIST DRILL & MACHINE COMPANY

NEW BEDFORD, MASS., U. S. A.



STANDARD TOOL CO.

STANDARD TWIST DRILLS

STANDARD TOOL CO.

THE SHIELD STAMPED KIND

Greatest Efficiency

Accuracy and Durability

THE STANDARD TOOL COMPANY

New York, 94 Reade St.

Cleveland, 1260-1288 Central Ave.

London Office, C. W. Burton, Griffiths & Co. Burton Fils, Paris, France. J. Lambercier & Cie, Geneve.

GOULD & EBERHARDT

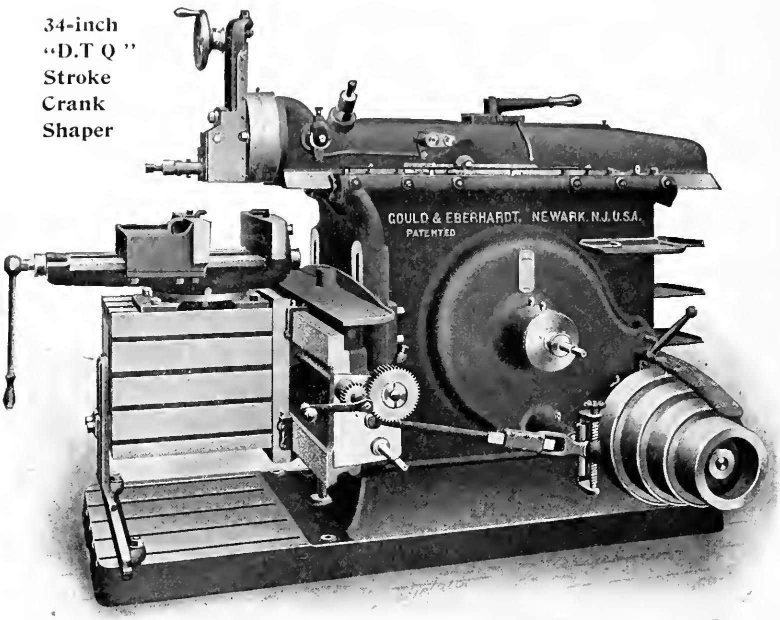
NEWARK, N. J., U. S. A.

Designers and Builders of HIGH CLASS MACHINE TOOLS.

AUTOMATIC GEAR CUTTING MACHINERY

HIGH DUTY SHAPERS

34-inch
"D.T Q"
Stroke
Crank
Shaper



Double the Number of Strokes

Can be obtained with the Eberhardts' Patent "Double Triple Quick" Stroke Shaper than with a machine of other construction. Through this system the cutting speed can be instantly changed to suit the metal being worked—slowed up for a short tool steel job, or pushed to the limit on brass or softer metals.

The largest of this style Shaper is the 34" size, a "high duty" machine, designed especially to get the best results from high speed steels. It is very powerful, runs smoothly, even at highest speeds, has eight speed changes for each change of stroke, and is equipped with our patent extension base—insuring rigidity even under the heaviest cuts; while the crank motion insures accurate work. There is a great deal of work now done on the planer that these Shapers can handle with equal efficiency and in less time. Write for Shaper Catalogue.

We build this style Shaper in 16", 20", 24" and 34" sizes. Motor drive when desired.

SELLING AGENTS—Baird Machinery Co., Pittsburg, Pa. Marshall & Huschart Machinery Co., Chicago and St. Louis. The Motch & Merryweather Mchy. Co., Cleveland and Detroit. The Fairbanks Co., Philadelphia and Baltimore. Henshaw, Bulkley & Co., San Francisco. Hallidie Mchy. Co., Seattle. Prentiss Tool and Supply Co., New York, Boston, Buffalo and Syracuse.

G & E SHAPERS "QUALITY"

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Milan and Paris. Selig, Sonnenthal & Co., London, England. John Lang & Sons, Johnstone, Scotland. F. W. Horne, Yokohama. Adolfo B. Horn, Havana, Cuba.

I am Schieren's oldest employee.

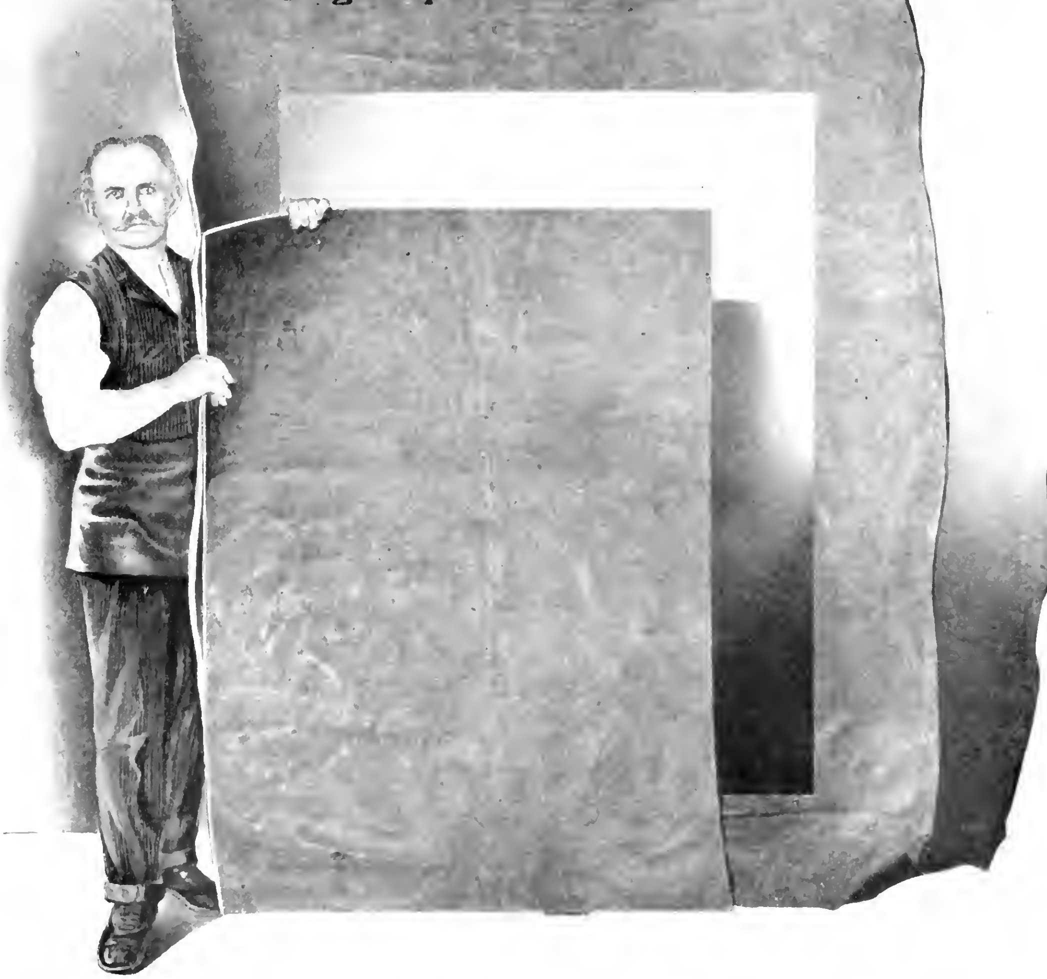
Been with the firm since they started business in 1868 and know the belting trade from A to Z.

Never pick a belt out for its thickness.

The thinnest and strongest part of any belting butt is that part nearest the line of the backbone.

The thickest and softest being nearest the outer edges.

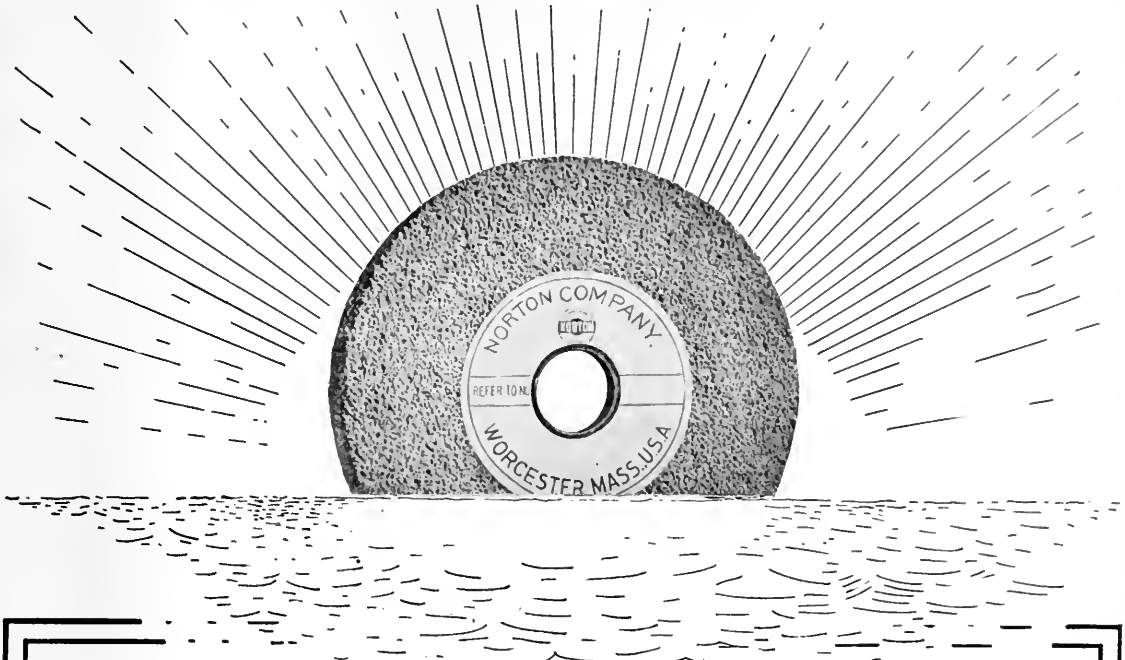
Schieren Belting has always been made from the thinnest and strongest part of the oak tanned hides.

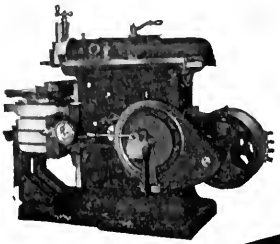


CHAS. A. SCHIEREN & COMPANY

29 FERRY STREET, NEW YORK

Boston, 191 Lincoln St.	Hamburg, Auf dem Sande, 1.	Philadelphia, 221 N. Third St.
Pittsburg, 239 3d Ave.	Chicago, 89 Franklin St.	Denver, 1513 Sixteenth St.

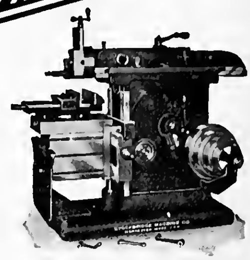

NORTON COMPANY
REFER TO No.
WORCESTER MASS. U.S.A.



That Patent Crank Motion as applied to Stockbridge Shapers gives a perfect crank motion, increasing production to a point where there is no economy in

Stockbridge TWO-PIECE Crank Shapers

running that old plain crank shaper. Better by far to scrap it



Stockbridge Machine Co.
WORCESTER, MASS., U. S. A.

Special Attachments

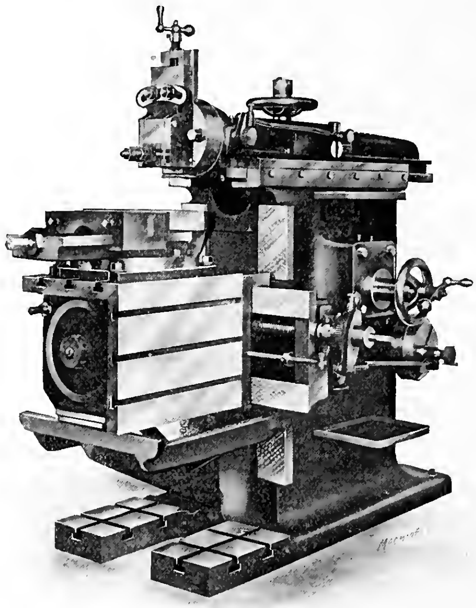
Swivel Box Table

Tilting Box Table

Circular Planing Attachment

Convex Planing Attachment

Oil-Pan and Pump



Special Tool Room Shaper with Attachments

Printed matter on request

Special Attachments

Concave Planing Attachment

Automatic Stop for Saddle

Rack-Cutting Attachment

Index Centers

The Mark Flather Planer Co., Nashua, N. H., U.S.A.

VC FOR QUALITY

Automatic Friction Feed

Automatic Stop

Power Return

The Higley Metal Saws

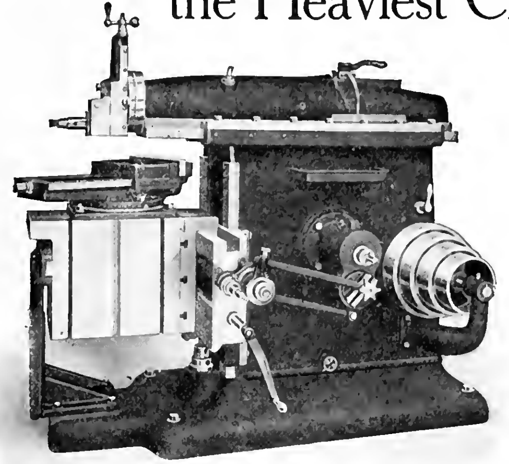
ARE EFFICIENT AND ECONOMICAL

"Higley" drive means thin saw blades pulled through the work, less stock removed and less power required. Result, the fastest cuts on record.

Vandyck Churchill Company

New York Philadelphia Pittsburgh New Haven

The Queen City Shaper has Power to Handle the Heaviest Classes of Work



and is especially suited for severe continuous service. For railroad work and heavy machine shop duty a 24-inch Queen City Back-geared Shaper can hardly be equalled. The arched construction of the ram adds to the strength and rigidity of the machine, as does also the very heavy rail, and ample wearing surfaces. The ratio of back-gearing is 29 to 1 giving full benefit from high speed steels. The workmanship throughout is the best, and convenience in operating is an important consideration. All changes—speed, stroke, feed, etc., are made from the working side of the machine, a handle for shifting from single to back-geared and vice versa is located just above the cone pulley; the table has outer support, and the improved telescopic screw makes cutting a hole in the floor unnecessary.

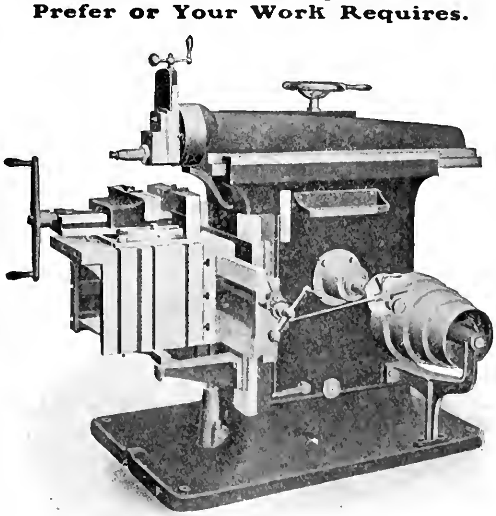
We also build this Shaper in 16-in. and 20-in. sizes and shall be glad to send catalogue.

Queen City Machine Tool Co., Cincinnati, O., U. S. A.

FOREIGN AGENTS: J. Lambercier & Co., Geneva, Switzerland; DeFries & Co., Dusseldorf and Berlin, Germany; Paris, France; Milan, Italy.

Kelly 26-inch. Shaper

Back Geared or Plain Just as You Prefer or Your Work Requires.

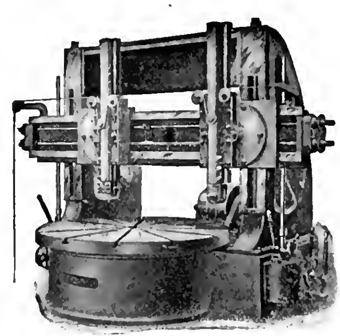


Adapted for severe service. Strong and Durable. Eight cutting speeds without stopping the machine. Equal rigidity on long or short stroke. Table support a part of the machine.

Write for Crank Shaper Catalogue.

15, 17 and 20" stroke Plain.
16, 20, 24 and 26" stroke Back Geared.

THE R. A. KELLY CO., Xenia, Ohio



The Power is There—

Power and rigidity are strong points in the construction of **Poole Boring Mills,** ensuring the best results from high speed steels every time. They are built for heavy work and handle it rapidly and accurately. Every facility for ease in operating.

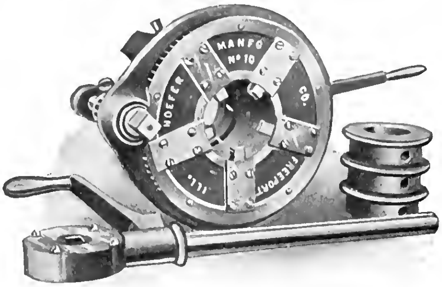
Four sizes, 6, 7, 8 and 10 foot. Power traverse for cross-rail, cross-heads and tool bars. Twenty-four changes of speed; eight universal feeds.

Full description of any or all sizes if you will ask for it.

The J. Morton Poole Company

WILMINGTON, DEL.

AGENTS: Prentiss Tool and Supply Co., 115 Liberty St., New York, 145 Oliver St., Boston, 507 D. S. Morgan Bldg., Buffalo. Hill, Clarke & Co., Chicago. W. C. Johnson & Sons M'chy Co., St. Louis. Tatum & Bowen, San Francisco.



Adjustable Hand Power Pipe Threading Machine.

The New Hoefer Pipe Threading Machine

has special advantages for work within its range. It is a hand power machine, adjustable, and can be operated by one man. It will thread pipes of any material; dies are fed forward and automatically withdrawn; can be quickly adjusted to cut over or under size and one set of dies will cut all sizes of threads within the capacity of the machine.

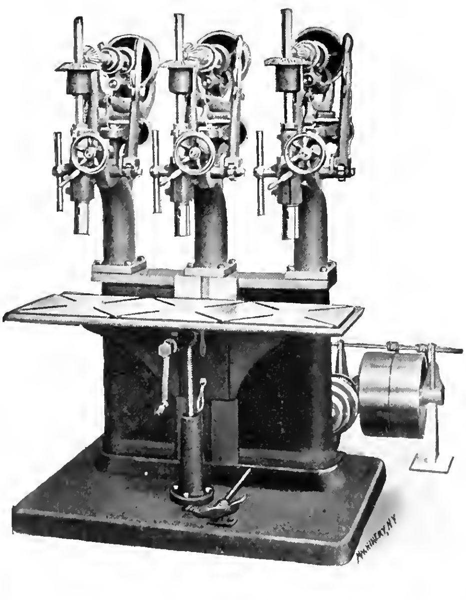
We manufacture **Drill Presses, Metal Saws, Horizontal Drilling and Boring Machines, Vertical Boring Machines, Wire Straighteners, Pipe Threading Machines, Furniture and Bed Spring Machinery.**

SEND FOR LATEST CATALOGUE.

Hoefer Manufacturing Company

Cor. Chicago and Jackson Sts., Freeport, Ill.

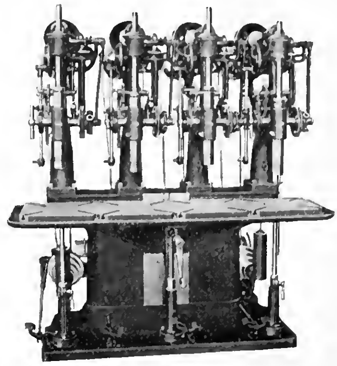
FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. J. Lambercier, Geneva, Switzerland.



24-inch Gang Drill.

Automatic Gang Drills

BUILT FOR BUSINESS



Our Manufacturers Drills will do your work surprisingly quick, pleasingly accurate and with a big saving in operative cost. One man does the work of four to six operators. No feed levers—spindles are automatic. The operator is kept busy feeding the machine with work. No time is lost on the part of either the machine or the operator.

Built in 14 inch, 20 inch and 23 inch sizes—all cost reducers and profit producers.

Want to know more about these machines and who are using them? Let us tell you.

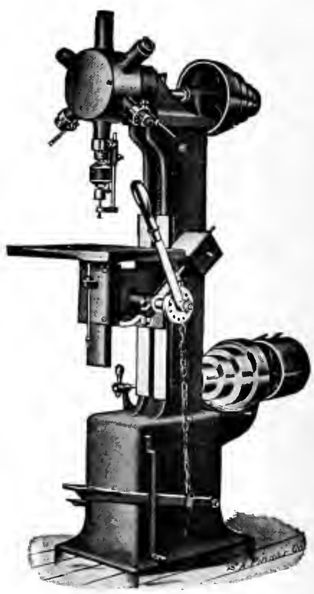
B. F. Barnes Company, Rockford, Ill.

European Branch: 149 Queen Victoria St., London, E. C.

Quint Turret Drills

Do all the work—Bore, Drill, Tap—and all at one setting of the work.

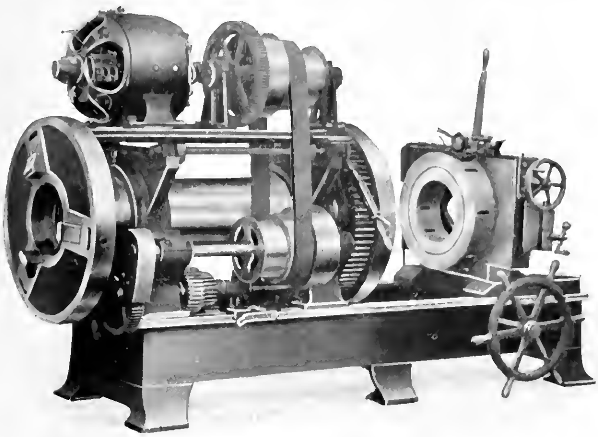
The No. 2 Pattern as shown is arranged for tapping, and is especially adapted for light work where accuracy is essential. It will drill to $\frac{5}{8}''$ and tap to $\frac{1}{2}''$, without stopping to change work or tools. Positively driven with steel bevel gears. Reversing Tap Holder will tap to required depth and automatically back out more than twice as fast as when cutting. Independent stops for depth of holes. Made with from 4 to 12 spindles.



Catalogue for full description.

A. E. Quint, Hartford, Conn.

Duplex Threading and Cutting-off Machine with Motor Drive



This is the

Improved Duplex, No. 12

It has capacity for threading and cutting-off pipe from 4″ to 12″ inclusive, and is one of the most rapid and convenient machines of its type.

The die head is simple but effective; all adjustments are made by hand and dies may be inserted without removing any of the parts. Front and rear chucks are interchangeable; the reaming tool is located on the cutting-off slide; and handling small pipe is facilitated by a special bushing furnished with the machine.

We make a full line of Pipe Machines and shall be glad to forward circulars.

Bignall & Keeler Mfg. Co., Edwardsville, Ill.

HAVE YOU EVER THOUGHT OF THIS?

A makes gears.
B makes cutting tools.
C makes castings.
D has an idea for a pipe threading and cutting machine. He cannot make the different parts because he don't know how. He can only put them together.
He buys the base from C; the tools from B; the gears from A and other parts from E, F, G, and other manufacturers.
He has his men set up the machine. It runs, anyhow—anyway.
It looks rather nice.

BUT WILL IT DO THE WORK?

Can you trust that machine? Can you depend upon each and every part to do its full share of work and not shirk?

Can you depend upon the assembler of that machine to stand behind each and every part? Can you get satisfaction from him if it breaks? You know the answer.

MERRELL PIPE THREADING AND CUTTING MACHINES
must do the work or they cost you nothing.

We make each particular part and stand behind the whole machine. We are a responsible company.

We're so sure it will do the work that we give it to you for full 30 DAYS ABSOLUTELY FREE TRIAL.

Some pipe threading machines are built today as they were twenty years ago. Not an important improvement.

The MERRELL is an old—yet new—machine. We are the oldest sole makers of pipe threading machines in existence today. Yet we make our machines better each year.

Will you let us show you where and why MERRELL machines are best for you—without charge to yourself?

Quick shipments. Write today for free catalogue.

WATCH LATER ADVERTISEMENTS FOR FURTHER FACTS.

THE MERRELL MFG. CO., TOLEDO, OHIO

Registered in U. S. and Can. Pat. Offices.

LUMEN BRONZE BEARINGS

For nearly every variety of machinery.

A SAVING OF 30 PER CENT.

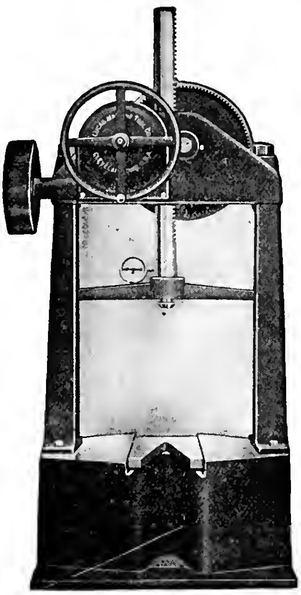
LUMEN BEARING COMPANY

WILLIAM H. BARR, General Manager.

Buffalo, U. S. A. Toronto, Canada.

Why Break Your Back

or ask your man to break his when it is possible to get such a machine as the



LUCAS POWER FORCING PRESS

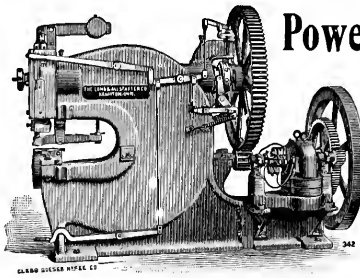
which will do your bending, broaching, straightening, forcing of arbors, pins or bushings in and out of holes

CHEAPER, BETTER AND QUICKER

than a hand press. A gage tells the pressure you get.

Lucas Machine Tool Co., Cleveland, Ohio, U.S.A.

Foreign Agents: C. W. Burton, Griffiths & Co., London; Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona.



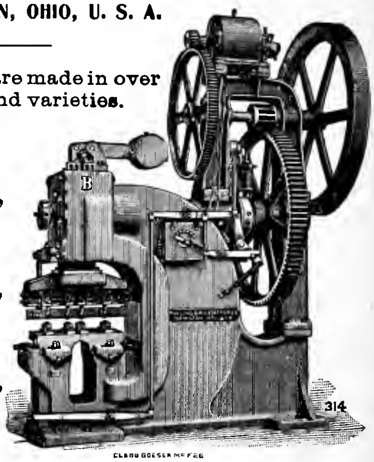
Power Punching and Shearing Machines

Belt, Steam and Electrically driven.

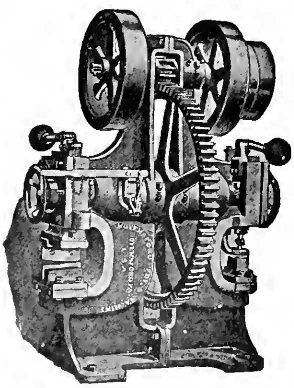
LONG & ALLSTATTER CO.

HAMILTON, OHIO, U. S. A.

Our machines are made in over 350 sizes and varieties.



SINGLE,
DOUBLE,
UPRIGHT,
HORIZONTAL,
GATE,
MULTIPLE,
FOR
Railroad Shops,
Locomotive Shops,
Bridge Works,
Etc.



No. 1 Automatic

Are you interested in the Best

PUNCH AND SHEAR?

Then ask us about the

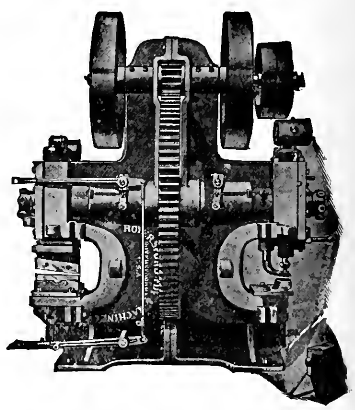
ROYERSFORD

BUILT FOR SERVICE.

VARIOUS SIZES. REQUIRES LITTLE FLOOR SPACE.

ROYERSFORD FOUNDRY AND MACHINE COMPANY,

ROYERSFORD, PA.

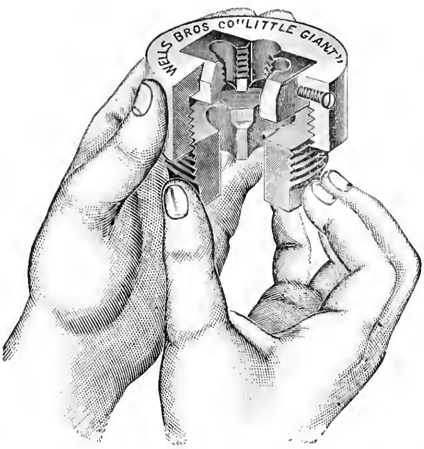


No. 3 Heavy Duty, 12 in. Throats

SIMPLICITY ITSELF

The cut herewith is so plain that it would be impossible not to clearly see the workings of the "Little Giant" die. See how solid it can be made, and yet with such ease. The bevel of the die fits into the bevel of the cap and the guide holds it rigidly in place.

There are many other good points. Send for Catalog.



Little Giant.

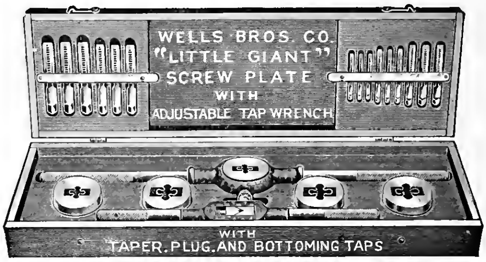
Manufactured by

WELLS BROS. COMPANY

GREENFIELD, MASS., U. S. A.

New York Store, 56 Reade Street.

London Store, 149 Queen Victoria St.



This set of Slocomb Micrometers should be in every Tool Room

Sizes include 1″ to 12″ gauges. They are always in place, always ready, and 12 men can be provided with a reliable caliper at one time.

The Accuracy and Durability

of Slocomb Micrometers has been amply tested by long service in the best machine shops. The peculiar form of construction, with an unusually long bearing between the nut and screw, and an adjustment which permits this bearing to be maintained, assures a particularly serviceable gauge for every day work.

The first cost is low—the staying qualities the greatest—accuracy beyond question.

It is **Slocomb Micrometers** you need.

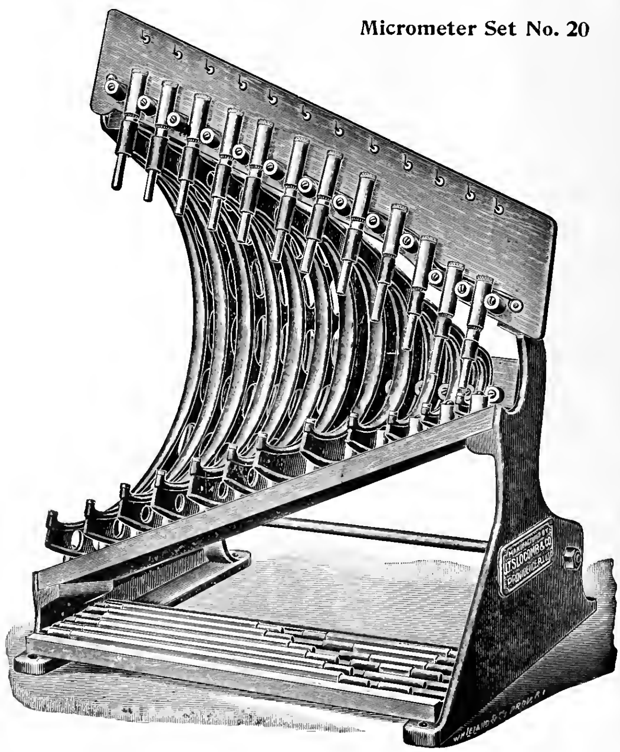
13 sizes, 74 styles.

Send for Catalogue No. 11.

J. T. Slocomb Company

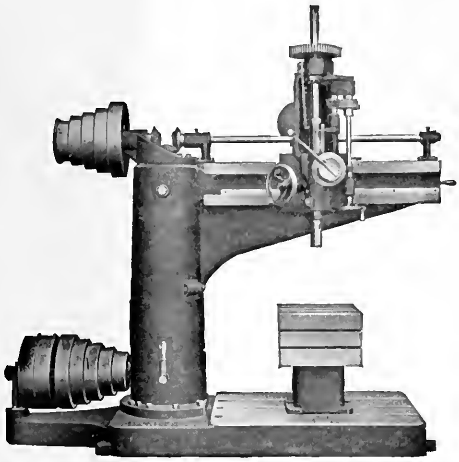
Providence, R. I., U. S. A.

Micrometer Set No. 20



AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. Ludw. Loewe & Co., Berlin, Continental Europe. McLean & Sophus, 301 St. James St., Montreal, Canada.

For Many Classes of Work



The chief characteristics of this machine are rigidity, simplicity and durability, which combined with a high ratio of transmission gears make it admirably adapted for many classes of work—it being particularly effective for heavy drilling and tapping—our 4 ft. size back-geared machine being able to pull a 6" tap through cast iron at 11 revolutions of spindle per minute.

Send for Circular.

The Bickford Drill & Tool Co.

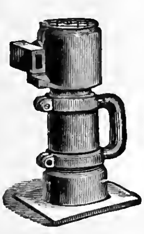
Send for Drilling Extraordinary.

Cincinnati, Ohio, U. S. A.

Send for 56 Points of Vantage.

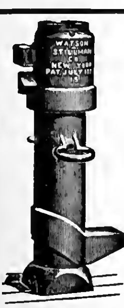
FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, New York. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, New York. Charles Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Andrews & George, Yokohama, Japan. H. W. Petrie, Toronto, Canada. Williams & Wilson, Montreal, Canada.
S. R.—4.

What do you Lack in our Line?



We make Hydraulic Tools of every description and for all needs, but among the hydraulic jacks the latitude in the matter of choice is perhaps greatest—257 styles, and every one of them built to meet the demands of the severest service. Ably designed, strongly built, long wearing tools.

JACKS



When you write us about jacks, you might as well get some points on other tools you may need later on. Special catalogues of Presses, Pumps, Punches, Shears, Benders, Valves, Accumulators, Gauges, Fittings, Tube Expanders. We build special tools to order.

The Watson-Stillman Company,

26 Cortlandt St., New York, U. S. A.

Chicago Office, 453 Rookery.

Counting the Cost

Is a big item in the busy factory. The labor cost of production has an immense bearing on the profits, and too much care cannot be used to have the records accurate.

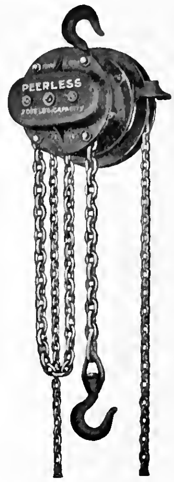
The CALCULAGRAPH

keeps a clear, accurate record of every piece of work from start to finish, and furnishes a permanent record of each job in convenient form for reference. It takes the place of an expensive clerk, saves the time of the busy workman, and being mechanical, can make no clerical errors. The CALCULAGRAPH mechanically subtracts the time a man begins his work from the time he finishes it, printing the actual working time. Think it over a little, then let us send you full description of the machine.

CALCULAGRAPH COMPANY
1441 Jewelers' Building, NEW YORK, U.S.A.

The Peerless Hoist

IS A PRACTICAL ECONOMY FOR YOUR PLANT.



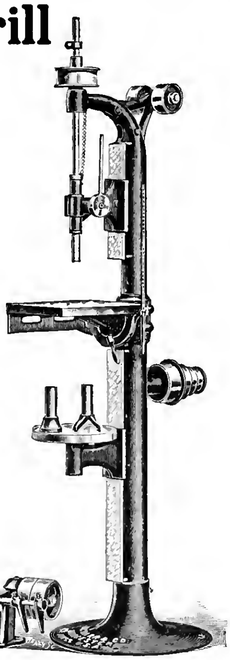
It is always ready, can be operated by unskilled labor, works faster, easier, and has a higher factor of safety than any other hand hoist.

The single load chain is an advantage — fewer strands of chain—and the compact form and light weight are further points of favor. It is spur-geared, insuring free, smooth action; durable, all working parts enclosed in dust-proof cases, and provided with an automatic clutch for holding the load at any point.

Suited for the hardest service.
Write for further details.

Edwin Harrington & Son, Inc.
PHILADELPHIA, PA., U. S. A.

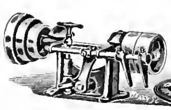
No. 4 Fourteen Inch Vertical Drill



with square tilting table for drilling at any angle, round table, vertically adjustable on column, cup and crotch centers.

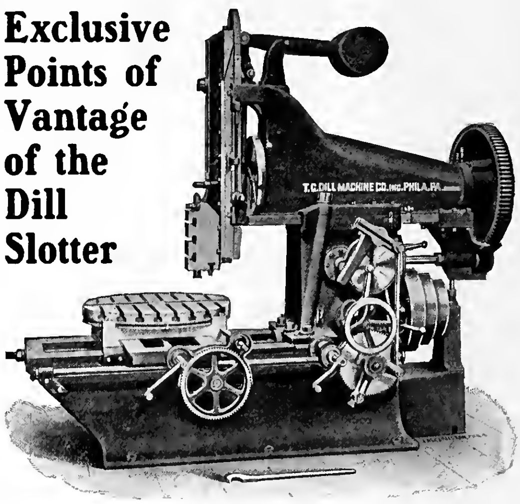
One of the most convenient tools for sensitive and rapid drilling. The pulleys are larger, belts longer and the power increased. It will drill holes up to ½″ diameter, has counterbalanced spindle, sliding head, lever feed and finest workmanship throughout.

Write for special circular of this machine, one of over 30 styles Single and Multiple Drills manufactured by



H. G. BARR, Worcester, Mass.

Exclusive Points of Vantage of the Dill Slotter



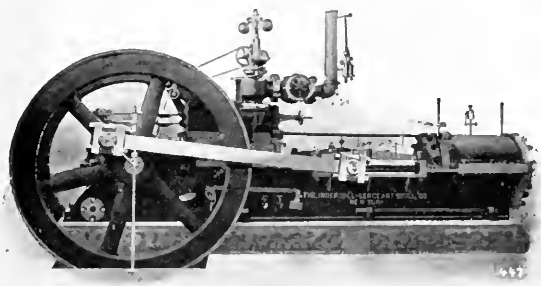
Traveling Head.	New Intermittent Feed.
Improved Quick Return.	Table Graduated in Degrees.
Quick Traverse Gear.	Hand Wheel Controller.
Wide Range of Speeds.	Tool Post in Relief Apron.

And other features of construction that make it a power for the machine shop.

Write for catalogue.

The Dill Slotter People
Philadelphia, Pa., U. S. A.

STRAIGHT-LINE
AIR COMPRESSORS



CLASS "A"

Simple in Design, with minimum number of parts and direct, positive application of power to resistance.

Self-Contained in type, permitting the simplest foundation, with low cost of installation.

Completely Accessible in every part, permitting inspection and adjustment without the removal of any part.

Easily Managed, ensuring high class results over long periods without expert attendance.

Self-Regulating under all variations of load and operating conditions.

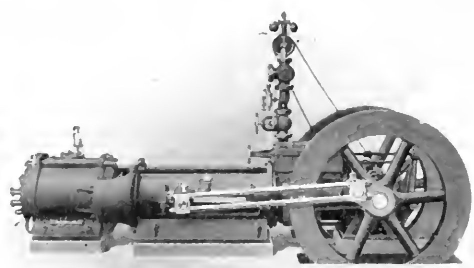
A Superior Type for all purposes demanding moderate capacity, good economy, great reliability and moderate cost of installation and up-keep.

PNEUMATIC TOOLS

INGERSOLL-RAND CO.

11 Broadway, NEW YORK

Chicago, Cleveland, Philadelphia, Houghton, Mich., St. Louis, Pittsburg, El Paso, Boston



CLASS "RC"

K 24

AIR COMPRESSORS

Capacity 1 to 70 cubic feet free air per minute.

BELTED MOTOR DRIVEN Single and Three Cylinder Styles

Write for Catalogue

THE F. W. SPACKE MACHINE CO.

INDIANAPOLIS, IND., U. S. A.

GEAR CUTTING - SPROCKET CUTTING

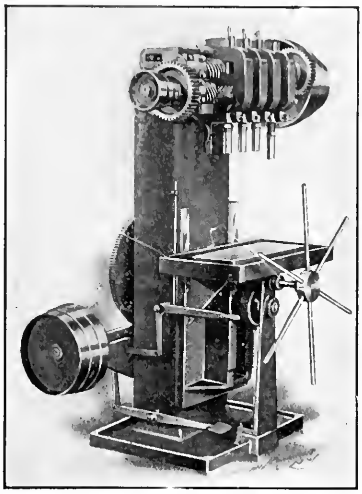
We maintain a special department for this division of our business. - Let us furnish estimates.

The King Machine Tool Company.

CINCINNATI, OHIO, U. S. A.

VERTICAL TURRET BORING AND TURNING MACHINES

THE VERY POWERFUL GEARED FEED



is a feature of our new

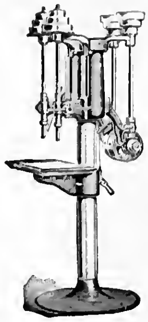
No. 7 Gang Drill

This machine has capacity for drilling ¾" holes within 2½" of each other and adjusts out to 20". The spindles are vertically adjustable, run in bronze bushings and are driven by bronze spiral gears; table is counterbalanced, with automatic stop and quickreturn; three changes of feed and three speed changes. Distance from nose of spindle to table 17".

Write for full description.

MOLINE TOOL COMPANY, MOLINE, ILL.

Marshall & Huschart Machinery Co., Chicago Representatives.
Chandler & Farquhar Co., Boston Representatives.



SENSITIVE DRILLS

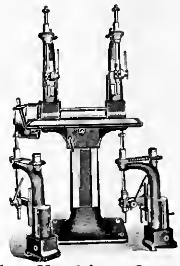
With or without power feed.
1 to 12 spindles.

SEND FOR CATALOG.

Francis Reed Co.
43 Hammond Street, Worcester, Mass.

Mighty handy for jig work

Our Manufacturers' Drill has adjustable top columns, three changes of speed for each spindle entirely independent of each other, lots of power, positive drive, quick changes of speed and plenty more good features which we can't tell about here. Get the catalog.

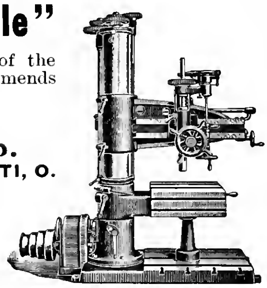


1 to 6 SPINDLES.

The Fenn-Sadler Machine Co.,
Hartford, Conn., U. S. A.

"Swinging Round the Circle"

The arm making a full circle is only one of the features of the **Mueller Radial Drill** that recommends it above similar machines—there are others.
Write us for book with full details.



Mueller Machine Tool Co.
216 W. Pearl St., CINCINNATI, O.

FOREIGN AGENTS—London, Niles-Bement-Pond Co. Japan, China and Far East, Mitsui & Co. Holland, H. G. Aikema & Co., Rotterdam. Switzerland, J. Lambercier & Co., Geneva. Italy, Vaghi, Accornero & Co., Milan. Sweden, Sam. Lagerlof, Stockholm. Montreal, Canada, The Canadian Machinery Agency. Hawaiian Islands, Henshaw, Bulkley Co. Honore Demoor & Co., Brussels, sole agents for Belgium and France.

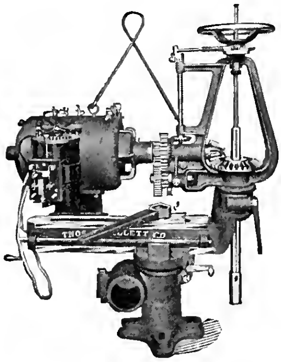
Save TIME, PATIENCE, and the T Slots in your Planers and Boring Mills by using

Lang's T Heads

Studs used instead of Bolts.
Drop Forged Steel. Case Hardened.

G. R. Lang Co., Meadville, Pa.
Peter A. Frasse & Co., New York.

Dallett
PORTABLE
Drills

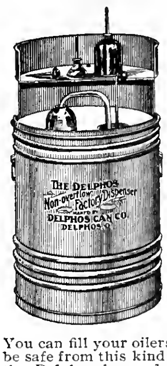


Are adapted to all classes of drilling. No matter how or where the hole is to be run the DALLETT can do it, and do it with less fuss and bother than if the work was taken to a stationary drill.

Let us send you our catalog showing the many styles we make.

THOS. H. DALLETT COMPANY,
York & 23rd Sts., PHILADELPHIA, PA.

No Chance for Oil to Run Over



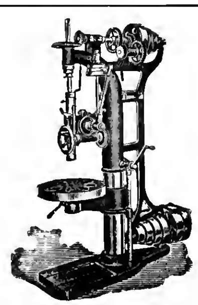
When you use the Delphos Non-Over-filling Factory Dispenser

You can fill your oilers in the dark and still be safe from this kind of accident, because the Delphos has a double tube spout—as soon as the oil gets up to the outlet tube the inlet tube gets busy and the oil is siphoned back into the can. See the advantage? Particularly adapted for filling hand oilers; pumps any kind of machine oil, does the work quickly and easily—no mess, no bother.

Send for Circular. 3, 5 and 10 gal. sizes; galvanized iron.

Delphos Can Co., Delphos, O.

A Good Drill Press is a Tool of Many Uses.



A SIBLEY DRILL in your shop is rarely idle. With proper jigs these machines will accomplish a very large amount of work at a very low labor cost. They are rapid, accurate, have a wide range, are adapted for light or heavy work as occasion requires, and are fitted with all the latest improvements.

Write for Catalogue showing Styles and Sizes of Power Drills.

Sibley Machine Tool Co., South Bend, Ind.

Successors to Sibley & Ware.

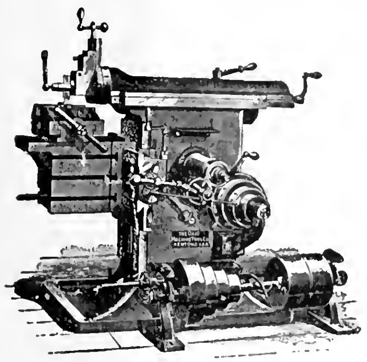
Our Combined Separator and Filter

IS A PRACTICAL OIL SAVER.
Does not require skilled attendant.
Sent on 30 days' trial if desired.

National Separator and Machine Co.
CONCORD, N. H.

16-in. Crank Shaper

Single or Back-Geared.

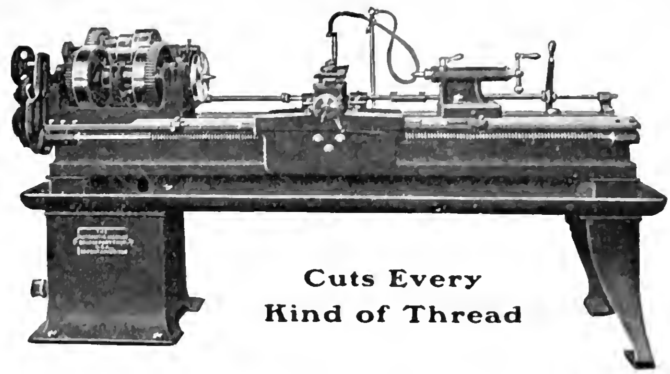


A well built, accurate machine. Heavy, powerful; ram unusually strong, with quick return. Stroke can be changed without stopping the machine. Head swivels; vise has graduated base, every improvement.

We also build 18" and 22" Crank Shapers, 21" and 28" Triple Geared Shapers, and Planers 24" to 38". *Write for circular.*

THE OHIO MACHINE TOOL CO., Kenton, O.

AGENTS: Marshall & Huschart Mchy. Co., St. Louis and vicinity. W. M. Pattison Mchy. Co., Cleveland and vicinity. Manning, Maxwell & Moore, Inc., New York, Philda. and Chicago.



Cuts Every Kind of Thread

The Automatic Threading Lathe

will cut internal, external, right or left hand, straight or taper threads with equal facility. It is entirely automatic in operation and will do from 25 to 100% more threading than the ordinary lathe, besides insuring accurate work. No special tools required. One attendant can operate several machines.

Hoist Worm made $1\frac{3}{8}$" x $3\frac{1}{2}$"—2 pitch.

on Automatic Lathe Time five minutes.

Send for latest catalogue.

Automatic Machine Co., Bridgeport, Conn.

BALL BEARINGS

AND

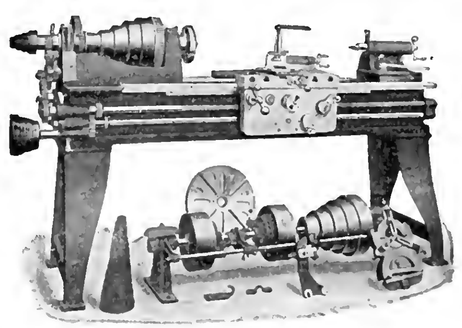
HIGH GRADE STEEL BALLS

We are manufacturers of Thrust and Radial Ball Bearings for all purposes; also of Steel Balls specially made and fully guaranteed.

May we send our booklet "Anti-Friction"? Instructive, interesting and comprehensive.

American Ball Company
Providence, R. I.

We Make Lathes a Specialty



Write for description of

New 15-inch Engine Lathe

with Instantaneous Change Gear Device

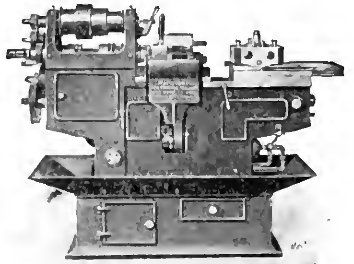
This improved tool will interest you

Von Wyck Machine Tool Co., Cincinnati, O.

THE NEW FORMING MACHINE.

MULTIPLE SPINDLE. FULL AUTOMATIC

For all kinds of screw machine work

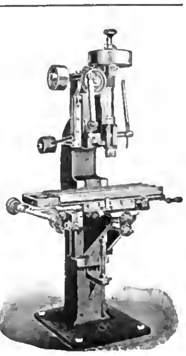


This machine is so constructed that the spindles act entirely independent of each other. Making parts simultaneously entirely different or exactly alike as may be desired. It is very rapid in all its automatic changes, and can be changed to cut different lengths or diameters in a few moments without change of cams. It makes screws, bolts, studs, balls, rollers, or any parts requiring drilling, counterboring, tapering, hollow or round, and does these things from two to four times as quickly as can be done on any single spindle machine and is the most accurate machine on the market.

James D. Mattison, 253 Broadway New York, U. S. A.

Vertical Miller and Slotter

Two Sizes



Slotter always ready to use and never in the way of milling. It will cut out those square corners quicker than any other machine. Prompt delivery.

Full particulars and prices sent on request.

R. M. CLOUGH,
TOLLAND, CONN.

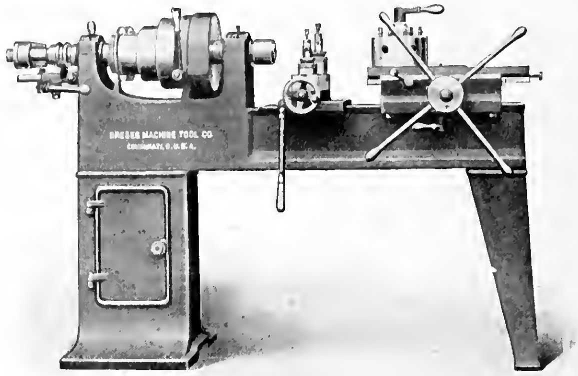
Finished Machine Keys

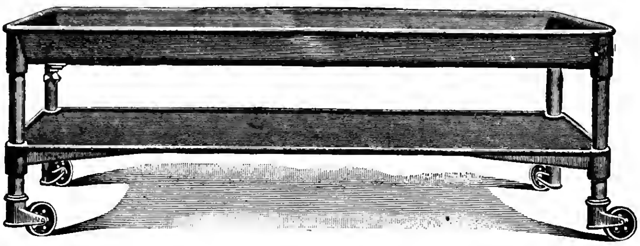
Gib and Plain Head.

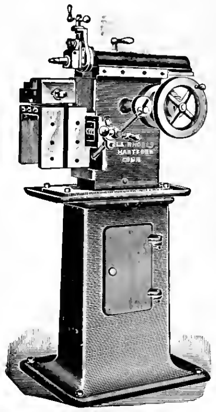
All sizes carried in stock. Write for discounts.

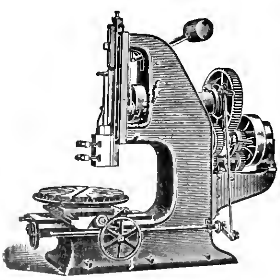
OLNEY & WARRIN,
66-68 Centre St., New York.

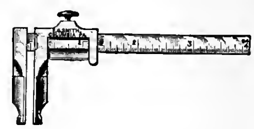
Cheaper than you can make them. Finished "Ready to Drive"


DRESES MACHINE TOOL CO.
CINCINNATI, O. U. S. A.



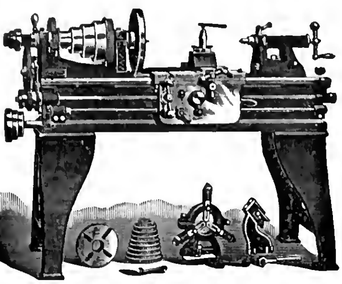






For Small or Medium Work

Try a Sebastian Lathe.



Fitted with all the latest time and labor saving improvements and adapted for the most accurate work. If your line of work is light manufacturing, this is the tool you need. Built in sizes from 13 in. to 15 in. swing; substantially constructed, carefully proportioned, convenient, economical.

CATALOGUE GIVES FULL DETAILS.

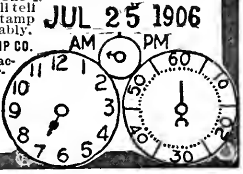
Sebastian Lathe Co., 129-131 Culvert St., Cincinnati, O.

Every Hour You Pay For

ought to be accurately checked by a Perry Time Stamp. You must know just the number of hours and minutes your workmen use in doing a job. You can have it all before you every morning truthfully, unalterably, accurately if you set a

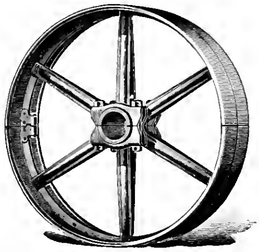
Perry Time Stamp

as guard over your interests. It's easy to handle. Works do not get out of order. It is self-inking, keeps accurate time, can be carried anywhere. It is durable and strong. Our book, "The Business Man's Time Saver" is Free. Send now for it, telling us in what parts of your business you might experiment with one 10 days free. We'll tell you how our Stamp will fit in profitably.



PERRY TIME STAMP CO.
Main Office and Factory, 19 So. Jefferson St., Chicago.
Eastern Sales Office, Room 307, 95 Liberty St., New York City.

Users of high speed Pulleys will appreciate



Patented in the U. S. and Foreign Countries.

The American
wrought steel Pulley

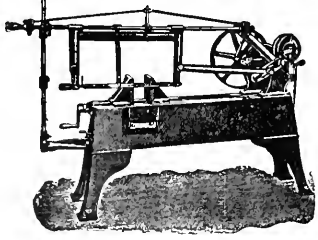
It embodies the Best ideas in practical transmission of power.

SOLD BY
SUPPLY HOUSES EVERYWHERE

The American Pulley Co.
29th and Bristol Streets,
Philadelphia, Pa., U. S. A.

JEFFREY ELEVATING, CONVEYING, POWER TRANSMISSION **MACHINERY** FOR CATALOGUE, ADDRESS THE JEFFREY MFG. CO. COLUMBUS, O.

Draw Cut Machine Saw No. 2



Capacity 10 in. x 10 in.

Cuts all kinds of cold metal, round, square or irregular shaped, smoothly, accurately and in less time than any other saw of its kind.

The improved features of this tool are:
Draw Cut, Geared Drive, Combination Feed, Adjustable Stroke.

Size No. 1 cuts 6" x 6". Circulars for details.

H. T. STORY
30 W. Randolph St., Chicago, Ill.

DIAMOND TOOLS FOR MECHANICAL USES.

THOS. L. DICKINSON, 45 Vesey St., New York City.

Professional.

INVENTIONS

Patents secured. Trade-Marks registered in the United States and foreign countries. Investigations made as to patentability of inventions and validity of patents. Booklet on patents sent free.

ROYAL E. BURNHAM,
Counselor at Law and Solicitor of Patents.
837 Bond Building, Washington, D. C.

PATENTS

PATENTS

HOWARD A. COOMBS
Attorney at Law

Formerly examiner U. S. Patent Office.
Member Am. Soc. Mech. Engineers.

317 McGill Building, WASHINGTON, D. C.

GARDNER ENGINEERING CO.
Consulting Mechanical Engineers and Manufacturers' Agents

Specialists in reducing manufacturing costs. Experts in the design and construction of Automatic Machinery for producing sheet metal and wire articles.

136 LIBERTY STREET NEW YORK

HOWSON & HOWSON,
Attorneys at Law, Solicitors of Patents.
32 South Broad Street, Philadelphia, Pa.
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PATENTS

PROTECT YOUR IDEAS

Send for Inventor's Primer.
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Branches at Chicago, Cleveland, Detroit.

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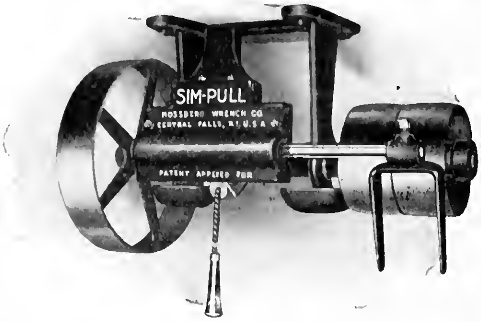
(Registered.) McGill Bldg., 908-914 G Street Washington, D. C.

HOISTS, New Patent Whip Patent Friction Pulleys. NONE BETTER. MANUFACTURED BY
VOLNEY W. MASON & CO., PROVIDENCE, R. I., U.S.A

Metal Polish

Highest Award
Chicago World's Fair, 1893.
Louisiana Purchase Exposition, St. Louis, Mo., 1904.
3-oz. Box for 10 cents.
Sold by Agents and Dealers all over the world. Ask or write for FREE samples.
5-lb. Pails, $1.00.
GEO. W. HOFFMAN,
Expert Polish Maker,
Indianapolis, Indiana.



HOW ABOUT THE COUNTERSHAFT?

In ordering a new machine the manufacturer is careful to specify the latest type with all improvements, but, how about the Countershaft? "Countershaft furnished with machine" generally means one that will let the machine builder off with the biggest profit. But where do you get off? Go out into your shop and ask "the man behind." He'll tell you the trials and tribulations he's had with all countershafts. The **"Sim-Pull" Countershaft** was designed to correct *all* the faults of other devices. It's a "pull" Countershaft, with half the "pull" left out, because the return of the handle helps to move the belt-shipper, it cannot stop half way. It never balks and is so simple, as to be proof against getting out of order. It's perfect self-oiling arrangement, alone, makes it superior to all others.

Isn't it about time to look into the Countershaft Question—write for catalog **MOSSBERG WRENCH COMPANY,** CENTRAL FALLS, Rhode Island

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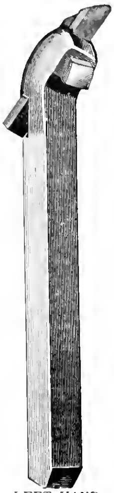
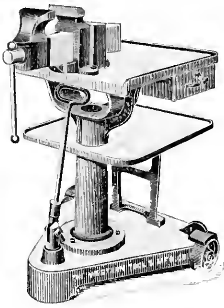


LEFT HAND

Wonderful Saving in Steel. Money Savers.



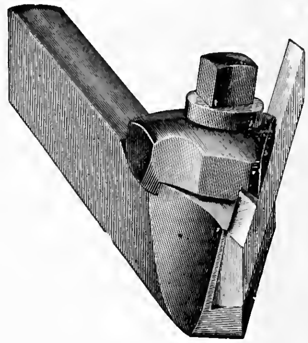
PORTABLE VISE STAND

Rapid Production Tools

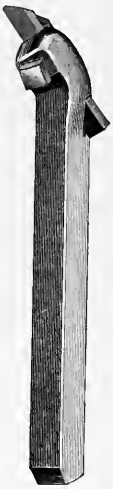
Tool Holders are drop-forged of Steel.

The patented support costs no more.

Insist on having it.



RIGHT HAND



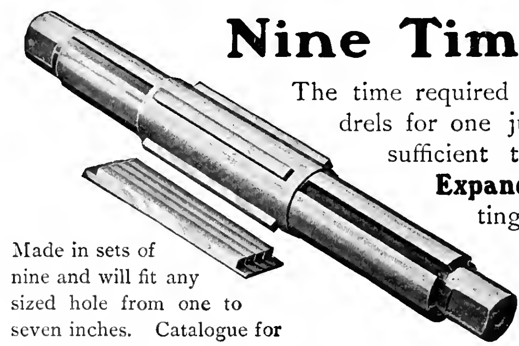
RIGHT HAND

Send for New Catalogue—it's free.

The Western Tool and Mfg. Co.

Springfield, Ohio

Nine Times out of Ten



The time required for a man to hunt through a pile of solid mandrels for one just the right size for the job in hand, would be sufficient to get the work half done with **Nicholson's Expanding Mandrels.** Isn't this worth investigating? Nicholson's Mandrels are strong, durable, compact and convenient. All parts interchangeable.

Made in sets of nine and will fit any sized hole from one to seven inches. Catalogue for full particulars.

W. H. Nicholson & Co., Wilkes-Barre, Pa., U.S.A.

FOREIGN HOUSES—C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Cologne Vienna, Brussels, Stockholm, St. Petersburg.

HIGH SPEED DRILLS IN STOCK

FULLY GUARANTEED

Capital Drills made from special drill quality are hard and tough.

They will run at the highest obtainable speed.

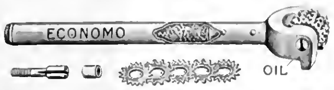
CAPITAL DRILLS WILL DO MANY TIMES THE WORK OF ORDINARY DRILLS.

BUY THE TOUGH ONES.

EDGAR T. WARD & SONS, 25 Purchase St., **Boston, Mass., U. S. A.**

"ECONOMO" Emery Wheel Dressers

Made of an abrasive nearly as hard as the black diamond. Will true and shape any wheels except the very hard and carborundum. The "Combination" Dresser is the roughing dresser placed in the "handle end" of the "Economo". The cutters of the "Combination" are made of "Crucible" steel and excel in wear and efficiency any dresser heretofore made.



Combination.

12-in. long. Shorter lengths on application.

Sent on fifteen days' trial. Circular mailed on request.

INTERNATIONAL SPECIALTY CO., 363 Holden Ave., DETROIT, MICH.

When in Doubt, try "Sterling"

You'll make no mistake because **Sterling Wheels** have every good feature an abrasive wheel should have. They are fast cutting, non-glazing, run equally well wet or dry and are graded to suit every grinding need.

New catalogue sent on request.

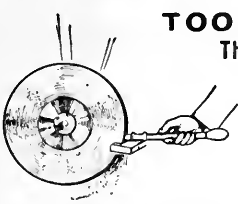
STERLING EMERY WHEEL MFG. CO.

Factories and Offices: TIFFIN, OHIO

BRANCHES: New York House, 45 Vesey St.
Chicago House, 30-32 So. Canal St.
San Francisco House, 7th and Berry Sts.

TOOL ROOM ECONOMY:—

The Use of Diamo-Carbo Emery Wheel Dressers.



The **Diamo-Carbo Dresser** is the only satisfactory substitute for the black diamond. Permits you to true and shape your wheels just the same as with the more expensive device, and is adapted for use on all tool grinding wheels. The hardest abrasive known; wears indefinitely; cannot get lost or broken and will not injure the edges of the most delicate wheels.

Made in three lengths: 8", 10" and 12" respectively.

Tell us which length is best suited for your needs, and let us send a Dresser on ten days' trial. Booklet and testimonials for the asking.

DESMOND-STEPHAN MFG. COMPANY, Urbana, Ohio

Do You Want a Cheaper Method of

GRINDING?

use a

Stow Flexible Shaft

and every month will show an improvement in operating cost for this department.

STOW FLEXIBLE SHAFT CO., Callowhill & 26th Sts., Philadelphia, Pa.

THE ULTIMATE COST

of any tool or machine is the only true test of economy—

The first cost may be a little higher, but if the tool does the work twice as fast and lasts twice as long, it is the cheaper in the end.

The ultimate cost of Carborundum Grinding Wheels is very low—

Because they do three times as much work in a day—last twice as many days and do cleaner and better work than any other abrasive in the world.

Carborundum Grinding Wheels are made in proper size, shape and grit to do every kind of work from the delicate grinding done in a watch factory to the heavy work of the manufacturer who turns out car wheels and steel rolls.

THE

Carborundum Company

NIAGARA FALLS, N. Y.

Our Ball Bearings

WILL SUCCESSFULLY CARRY EIGHTEEN TONS.

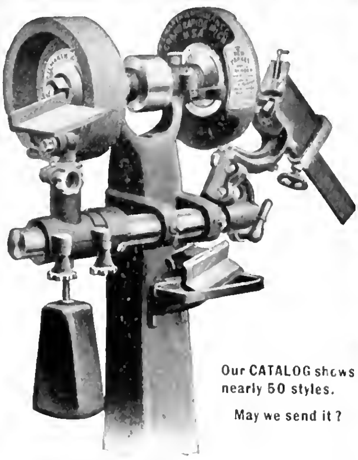
Auburn Ball Bearing Co.,

18 Commercial St., ROCHESTER, N. Y.

½ PRICE ON ONE SAMPLE to show why we deserve your business.

HAMPDEN CORUNDUM WHEEL CO., Springfield, Mass.

DO YOU KNOW A TOOL THAT IS USED MORE THAN A TWIST DRILL?



Our CATALOG shows nearly 50 styles.

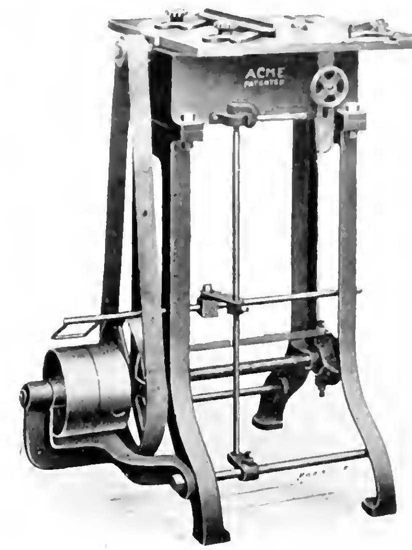
May we send it?

Do you know a tool that is more ABUSED than a twist drill? Ground by hand, so one lip does all the cutting, it's rammed through metal as if it were a punch. No wonder they drill holes larger than they ought to be. No wonder they break.

It's because the NEW YANKEE DRILL GRINDER grinds drills so the cutting is evenly divided between the two lips that drills thus ground do so much more work than others. They're also hard to break, for there's no undue strain on them. And as to the time it takes to grind them, this is far less than by hand, so there is a saving all around.

Wilmarth & Morman Co.
580 Canal Street, GRAND RAPIDS, MICH.

The "Acme" Metal Saw Table

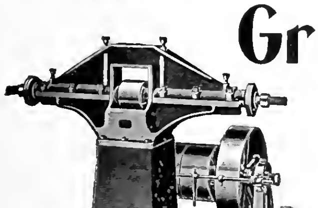


A compact, self-contained, all metal construction saw table for cutting sheet, rod or tube brass, copper, fibre, rubber, etc. Price **$50.00**, F. O. B. Philadelphia.

Catalogue mailed on request.

The Hub Machine & Tool Co.
621 Cherry Street, PHILADELPHIA, PA.

Emery Wheels and Grinding Machinery



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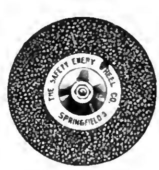
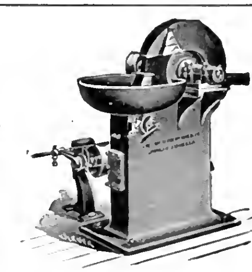




Foreign Agents:

Pfeil & Co., London.
F. Lowener, Copenhagen, Stockholm.
Adler & Eisenchitz, Milan, Italy.
Defries & Co., Act. Ges., Berlin, Dusseldorf.

THE SAFETY EMERY WHEEL COMPANY, Springfield, Ohio, U. S. A.

Pure Corundum Wheels

Fifty per cent. more efficient than any other abrasive wheel. Fast cutting, cool cutting, long wearing, will not glaze, will not draw the temper of the tool being ground.

These wheels are made from pure corundum by the vitrified process, are particularly uniform, durable and the most satisfactory abrasive wheels on the market.

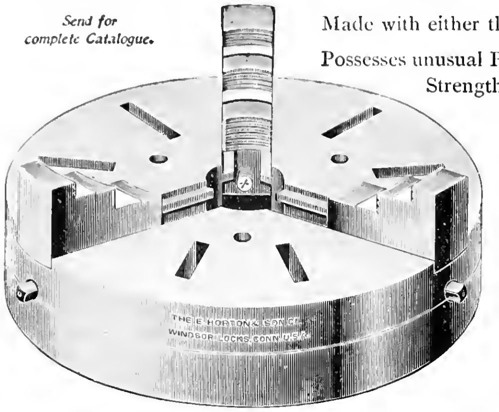
Write for latest catalogue.

Vitrified Wheel Company, Westfield, Mass.

New Chuck. Heavy Universal, Three Jaws

18 INCH AND UPWARDS.

Send for complete Catalogue.



Made with either three or four Jaws.

Possesses unusual Power, Rigidity Weight and Strength.

Built to withstand the severest strain.

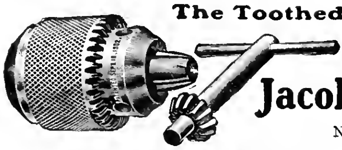
Corresponds with Modern Machine Tools.

We are Specialists, and make nothing but Chucks.

The E. Horton & Son Company,
Windsor Locks, Conn., U.S.A.

The Toothed Sleeve and Key is the feature

OF THE



Jacobs Improved Drill Chuck

No twisting of spindles when tightening drill

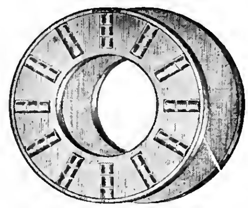
THE JACOBS MANUFACTURING CO., · 79 PEARL STREET, HARTFORD, CONN.

Standard Roller Bearing Co.

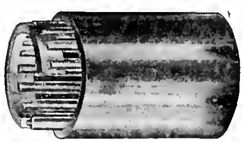
PHILADELPHIA, PA.

SEND FOR CATALOG.

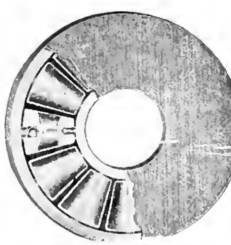
Ball Bearings
Ball Thrust Bearings
Roller Thrust Bearings
Tapered Roller Thrust Bearings
Save Power and Oil



Plain Roller Thrust.



Journal Roller Bearing.



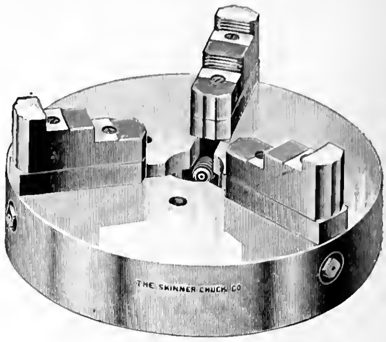
Tapered Roller Thrust.

ELECTROTYPERS

All kinds of plates for printing

THE LOVEJOY CO., Established 1863, **444-446 Pearl St., New York**

Skinner Lathe Chucks.



This is a three jaw Universal Chuck with patent reversible jaws—flush screw heads—also made as a Combination Chuck which can be used either universally or independently. Would you like a copy of our "1906 Price-List"?

THE SKINNER CHUCK COMPANY,

Factory, New Britian, Conn., U. S. A.
New York Office, 94 Reade St.

The Cushman Chuck Co.

HARTFORD, CONN., U. S. A.

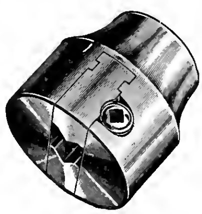
Manufacturers of

Lathe and Drill Chucks

Catalogue Free

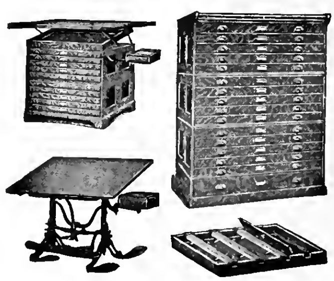
No Weak Places

In the Reid Drill Chuck.



One part is as strong as another. Outwears any other kind of chuck. Made right and sold at the right price. Circulars and price list mailed on request.

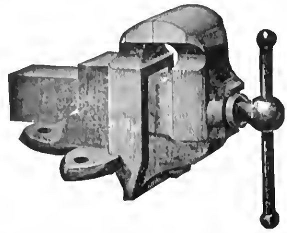
R. H. BROWN & CO.
New Haven, Conn.



Send for Catalogue

Fritz & Goeldel Mfg. Co., 60 Alabama St. Grand Rapids, Mich.

We Claim to Make the Best Line of Vises on the Market.

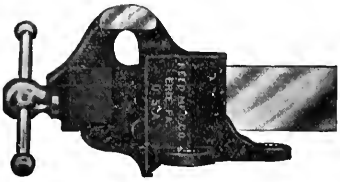


Send for catalogue 17 B, which also shows our full line of fine mechanical tools.

The Vise shown in cut is our "standard" pattern, made of first-class material so distributed as to produce the greatest strength and durability, the front jaw being reinforced from beneath. It is extra fitted, has jaws of best tempered steel, is convenient in use, and one of its greatest recommendations is the entire absence of complicated mechanism. Unquestionably the best solid nut screw vise made for machinists' use.

ATHOL MACHINE COMPANY, Athol, Massachusetts, U. S. A.

The Three R's in Vise Education

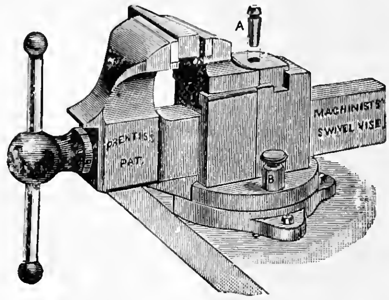


"**Reed**" on a machinists vise stands for
Reliable construction,
Right design and satisfactory results.

Ask your dealer for a Reed Vise and take no other. Sold under the strictest guarantee.

Catalogue H on request.

REED MFG. COMPANY, Erie, Pa.



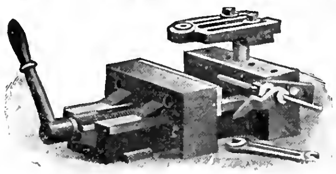
Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

Prentiss Vise Company,
44 Barclay Street, New York.

Agents for Great Britain, Chas. Neat & Co., 112 Queen Victoria St., London, E. C.

TRY THE UNIVERSAL JIG VISE



Our idea is to provide an absolutely satisfactory vise for general shop use and at the same time have a machine that will hold work for duplicate drilling without the cost of a jig.

Hundreds of users can testify how well the Graham Drill Vise fills this bill. May we have your opinion?

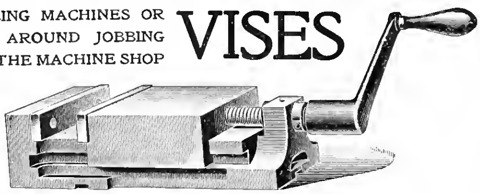
Circulars and full particulars on request.

THE GRAHAM MFG. CO., Providence, R. I.

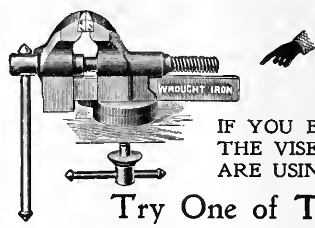
Canadian Makers: Imperial Vise Co., Galt, Ont. Fenwick, Freres & Co., Paris. Europe: Chas. Churchill & Co., London. Arthur Kayser, Berlin.

VISES FOR MILLING MACHINES OR FOR ALL AROUND JOBBING WORK IN THE MACHINE SHOP VISES

We have three sizes of these Vises in stock and can make prompt shipment. They are first-class in every particular. Send for circulars.



THE CARTER & HAKES MACHINE CO., WINSTED, CONN., U. S. A.
Or Manning, Maxwell & Moore, Inc., 85 Liberty Street, New York.



IF YOU BREAK THE VISE YOU ARE USING

Try One of These

MERRILL BROS.
469 Kent Avenue, Brooklyn, N. Y.

HIGH CLASS JOBBING

JIGS AND SPECIAL TOOLS

CONTRACT WORK

If your shop is over-crowded we can relieve you of troublesome Tool and Fixture work, and do it right.

THE P. A. GEIER COMPANY
224 High Avenue, S. E. CLEVELAND, OHIO

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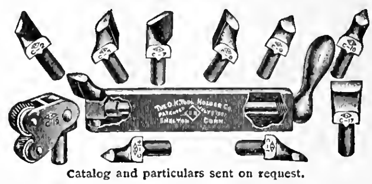
7 Holders in 1 with an assortment of 22 Tools & Fixtures



Catalog and particulars sent on request.

O. K. Tool Holder Co., Shelton, Conn., U. S. A.

IT IS SO EASY,

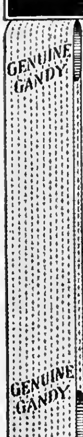
so very much easier to stick to what you have been using for a long time, than to make a radical departure, and try something altogether new. Yes, it certainly is, but the cost of such blind loyalty is often excessive. We have lots of regular users of our **Leviathan Belting**, who, for many years clung to leather, as the only really best belt possible. To what experienced men they knew said in praise of **Leviathan** may be traced their profitable and permanent awakening.

A brief booklet for the busy belt skeptic. Shall we mail it?

Main Belting Company
Sole Manufacturers
1217-1237 CARPENTER ST., PHILA.
55-57 Market St., CHICAGO
120 Pearl St., BOSTON
40 Pearl St., BUFFALO
309 Broadway, NEW YORK

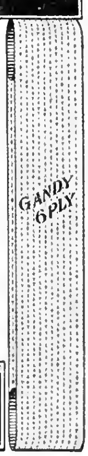
THE GENUINE
TRADE MARK GANDY'S BELTING REGISTERED

GANDY
PATENTED 1877



Takes a Grip that will not slip.

No matter how much the engine may be overloaded, when the fly-wheel turns the pulleys on the shafting have got to turn too if GANDY is used as a drive. That's one point in which it differs from leather or rubber belting. Another is its price which is 10 to 25 per cent. below rubber, and 50 to 75 per cent. below leather.



GANDY BELTING CO.
BALTIMORE, MD.

Easy Belts

Cling-Surface

They go together.

Ten years ago we began the crusade against the old expensive, troublesome practice of running belts tight.

Today there are hundreds of thousands of belts running easy with Cling-Surface in this country, several thousands in Great Britain, and hundreds in numbers of other countries.

There is absolutely no necessity for your running your belts tight, dragging along a great friction load, having frequent hot journals and pouring in oil to overcome the friction you are making and burning coal to drag it, and keep speed up.

Why should you?

Cling-Surface will let you run every belt you have easy or slack and pull more load than they are pulling now and without slipping. It will cut your friction load in half, give you higher speeds, economy of oil, fuel and trouble, and preserve your belts perfectly.

Cling-Surface is a preservative filler for belts and we absolutely guarantee the results.

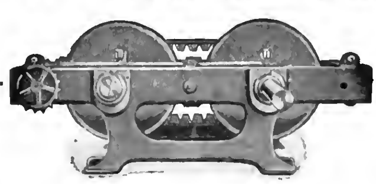
It is the economical, rational and certainly the best practice, proofs of which are everywhere about you.

Why then do you hesitate to order a trial package and try Cling-Surface?

Will you not send us an order?

CLING SURFACE CO. 153-159 Virginia St Buffalo N Y
New York Boston Chicago Philadelphia St. Louis
London: Thomas & Bishop, Balfour House, Finsbury.

ALL THE SPEEDS



Demanded for up-to-date work are not obtainable with a cone pulley. There are speeds between the steps of a cone pulley that may be essential to the work on hand, and these speeds and all the others are available through "The Reeves" Variable Speed Transmission. No trouble either—a turn of the hand wheel does it; saves time, saves shifting belts and stopping of work. Catalog?

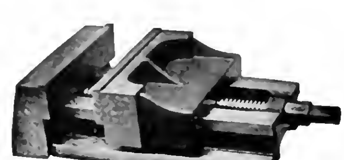
REEVES PULLEY CO., Columbus, Ind., U. S. A.

Plunket Improved Vise

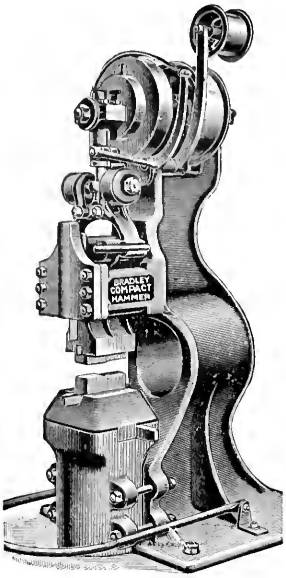
For Drill-Presses, Shapers and Milling Machines.

Built of best material and extra heavy to stand the strain of severe work in the machine shop. Steel screw, steel faces to jaw, cast steel handle with each vise. *Write for particulars and prices.*

J. E. PLUNKET, Chicago, Ill.
119 Washington Boulevard.



Bradley Compact Hammer.



If your forging is of a general, all around jobbing character with frequent variations in the size of stock, or

If it is of such a nature that the hammer is not working continuously, but with frequent stops, or

If your floor space is limited but with good height, a Bradley Compact Hammer would prove a money maker.

It is compact in design, occupies but little space and can be run at high speed.

As it weighs considerably less than our regular Upright Hammer its price is much less.

Made with head weighing 15 to 200 pounds.

WE MAKE....
The Bradley Cushioned Helve Hammer.
The Bradley Upright Strap Hammer.
The Bradley Upright Helve Hammer.
The Bradley Compact Hammer.
Forges for Hard Coal or Coke.

SEND FOR CIRCULARS

C. C. Bradley & Son, Syracuse, N. Y.

FOREIGN AGENTS: Schuchardt & Schütte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schütte, Cologne, Brussels, Liège, Paris, Milan, Bilbao. Buck & Hickman, Whitechapel Road, London.

Steam Hammers

In all sizes and for every requirement.

Single Frame & Double Frame

Most complete and extensive equipment for their manufacture.

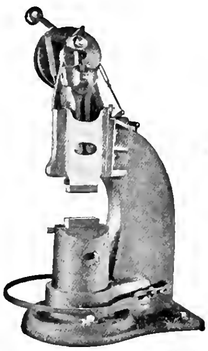
Largest and most modern line of patterns.

Also STEAM DROP HAMMERS
in all sizes up to 12000 lbs.
Falling weight.

CHAMBERSBURG ENGINEERING CO.
Chambersburg, Pa., U.S.A.

"The Rapidity and Weight of the Blow can be Perfectly Gauged."

Beaudry POWER Champion HAMMER

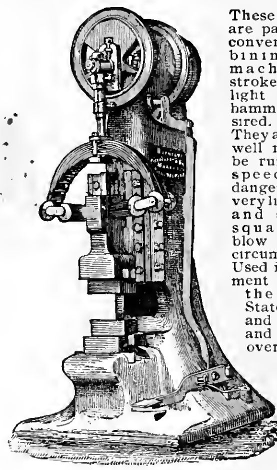


Adapted for Every Description of Forging

SIMPLE, DURABLE, EFFICIENT AND ECONOMICAL

Beaudry & Company 141 Milk St. **Boston, Mass., U.S.A.**

Spring Power Hammers

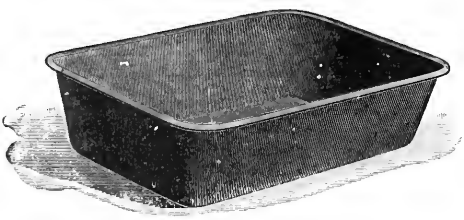


These hammers are particularly convenient combining in one machine the stroke of a very light or heavy hammer as desired.
They are strong, well made, can be run at high speed without danger, require very little power and strike a square, true blow under all circumstances.
Used in government shops by the United States, France and Russia, and sold all over the world.

DIENELT & EISENHARDT, Inc.
1304 No. Howard Street
PHILADELPHIA, PA., U. S. A.

Pressed Steel Shop Pans or Tote Boxes

For Machine Shops and Foundries, Bolt Works, Etc.
THOUSANDS IN USE. DURABILITY AND SATISFACTION GUARANTEED.



Cut of Size "H," without Handles.

Made of any Gauge of Sheet Steel desired. Never go to pieces as the common riveted boxes do, and always give entire satisfaction.

Try samples and you would not be without them in your works at any price.

Suitable for handling bolts, rivets, nails, screws, nuts, washers, castings, ore, quartz, and other substances, and for use under lathes and drill presses to catch the turnings, trimmings, borings, oil drippings, etc. Send for Catalogue

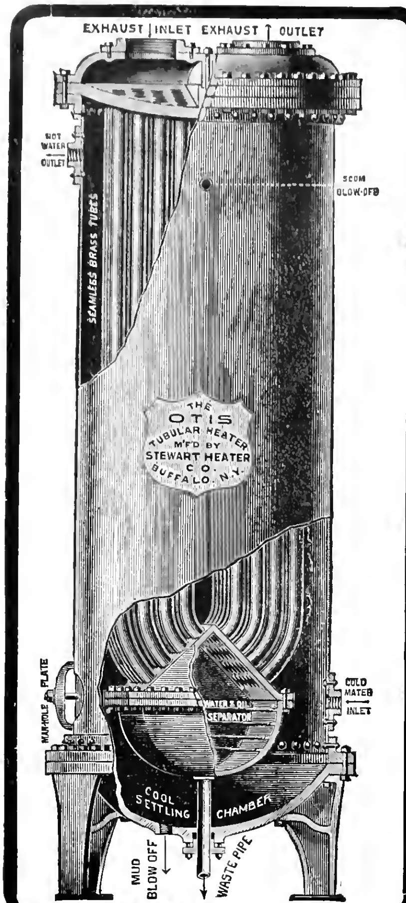
KILBOURNE & JACOBS MFG. CO., COLUMBUS, OHIO.

INDUSTRIAL LOCATIONS

The unparalleled growth of the cotton and other leading interests of the South has opened the way for scores of miscellaneous industries which are new to that section—industries which the increase in population and wealth imperatively demand.

For information about these opportunities in sections reached by the **Southern Railway** and **Mobile and Ohio Railroad,** write

M. V. RICHARDS
Land & Industrial Agent, WASHINGTON, D. C.
A. HELPER, Agent, 271 Broadway, N. Y. City



THE OTIS

Tubular Feed Water Heater, Oil Separator and Purifier

is not an experiment but a tried and tested appliance that the makers are not afraid to

GUARANTEE

To heat the feed water to the *boiling point* (210 or 212 degrees) with the exhaust steam without causing any back pressure, *also to extract the oil from the exhaust*, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all cost of a trial—freight, cartage, piping, etc., if it fails to do all we claim for it.

Catalogue and Prices at Your Service

The Stewart Heater Company

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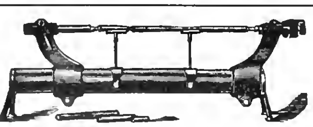
POOLE ENGINEERING & MACHINE CO.
ENGINEERS, FOUNDERS AND MACHINISTS.
BALTIMORE, MD.
MANUFACTURERS AND DESIGNERS OF ALL KINDS OF
HEAVY MACHINERY,
REQUIRING FIRST CLASS WORKMASHIP AND MATERIALS.
BAND, ROPE AND FLY WHEELS, FRICTION CLUTCHES, SHAFTING, PULLEYS AND HANGERS.
MACHINE MOLDED AND PLANED GEARING
MACHINERY for WHITE LEAD and FERTILIZER WORKS, GRAIN ELEVATORS and FLOUR MILLS, BRASS, COPPER and TIN PLATE ROLLING MILLS CABLE and MARINE RAILWAYS.
POOLE-LEFFEL TURBINE WATER-WHEELS
DREDGING MACHINES.
CIRCULARS ON APPLICATION.
IRON CASTINGS 30,000 LBS. TENSILE STRENGTH.

Dixon's Graphite Lightens Your Work

The use of Dixon's Flake Graphite on your engine will save you work and worry. Less oil will be required, piston packing will wear longer, and repairs due to faulty lubrication will not occur.

We will send you booklet 74-C fully explaining graphite lubrication and free samples at your request.

Joseph Dixon Crucible Company
Jersey City, N. J.



(Style of 12 and 24 sizes.)

Measuring Machines.

Measuring screw, 10, 16 or 20 threads to the inch, graduated to read thousandths or 32ds without calculation.

The only Micrometer that will not lose its accuracy by wear.

SYRACUSE TWIST DRILL CO., SYRACUSE, N. Y.

Chas Churchill & Co., Ltd., London, Eng., Agents for Great Britain

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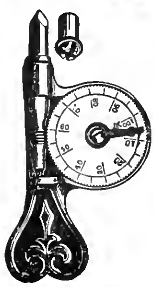


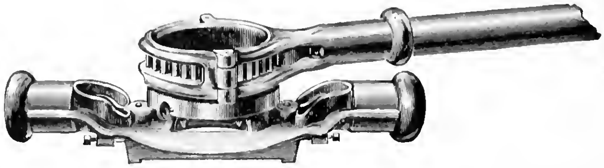
WOODMAN & HUDSON'S Speed Indicator.

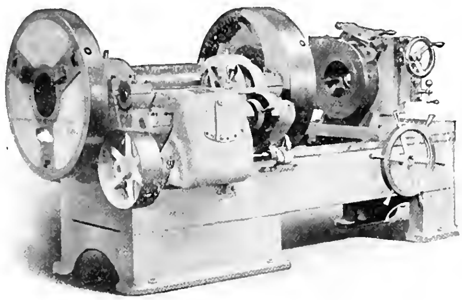
An ingenious little instrument for ascertaining the correct speed of Dynamos, Steam Engines, Shafting, Floor Machines, etc. No first class mechanic, superintendent or factory should be without one. They are adapted to hollow or pointed centers, and are absolutely correct. Every indicator is handsomely nickel-plated and of convenient size to carry in the pocket.

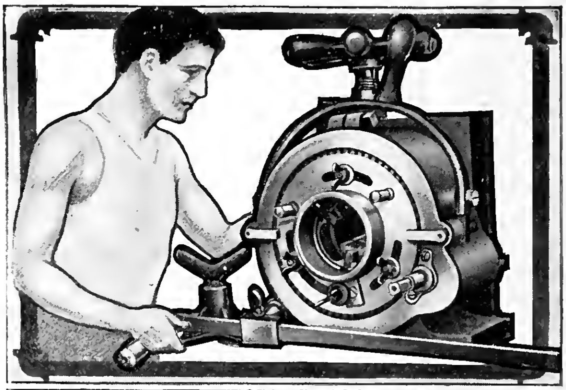
Price: Split Cap, adapted to either pointed or hollow centers, $1.00.
Plain Cap, for hollow centers only, 75c.

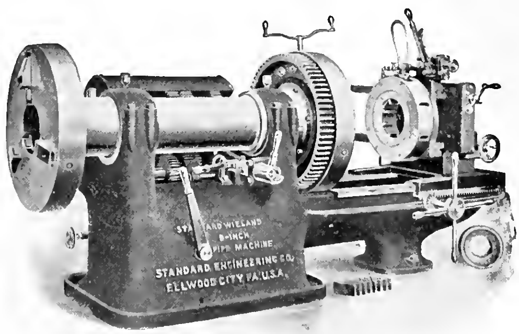
We also keep a Double Registering Speed Indicator. Prices on application.

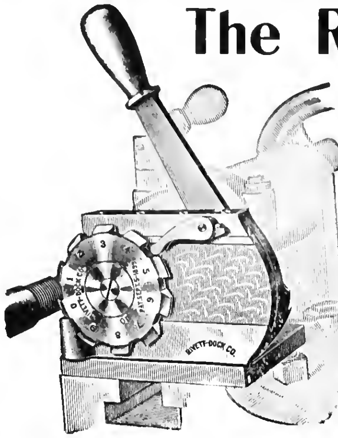
The R. Woodman Mfg. and Supply Co., 63 Oliver Street BOSTON, MASS.








STANDARD ENGINEERING CO.
ELLWOOD CITY PA.U.S.A.



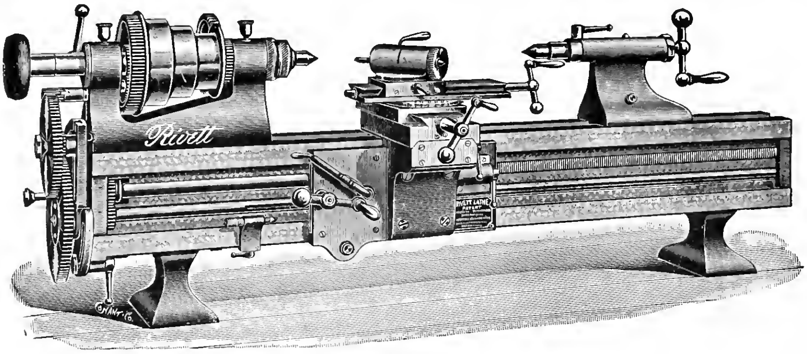
The Rivett-Dock Threading Tool

Has beaten the old single point tool to a standstill and is still rolling up new records. When you have accurate threading to do, and duplicate work this tool is practically indispensable—it not only does better work but will do it in from 1-3 to 1-10 the time formerly required, can be operated by unskilled labor and needs very infrequent grinding.

Let us send a tool on thirty days probation. A trial will convince you. 1906 Catalogue on request.

The Rivett-Dock Company, Brighton, Boston, Mass.

For Toolmakers, Makers of Fine Instruments, For Experimental Work



For all classes of work which require the extreme of accuracy,

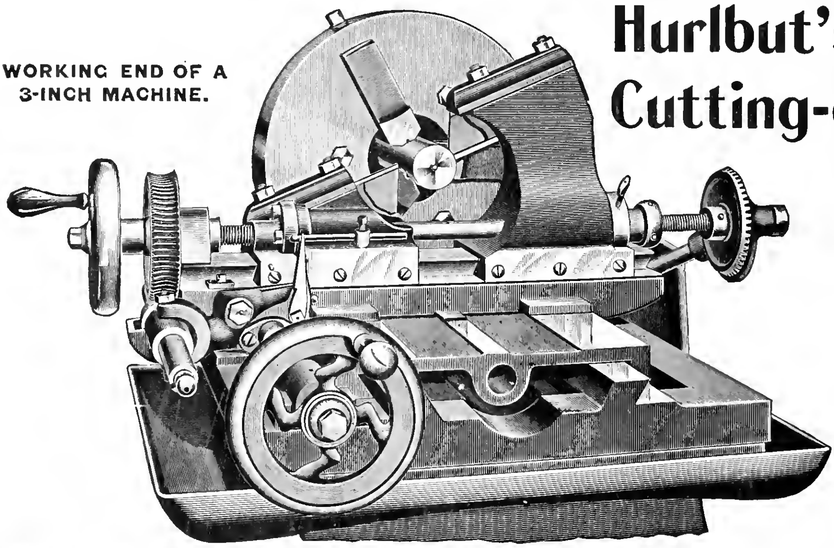
The Rivett Precision Lathe

comes nearer to the ideal than any other tool made. Though designed and adapted for the most delicate operations it has strength and rigidity to stand much heavier work and is equipped with every improvement.

Send for 1906 Catalog.

Rivett Lathe Mfg. Company, Brighton, Boston, Mass.

WORKING END OF A 3-INCH MACHINE.



Hurlbut's Patent Cutting-off Machine

Made in 2-inch, 3-inch, 4-inch, 5-inch, 6-inch, 8-inch and 10-inch sizes.

Circulars on application.

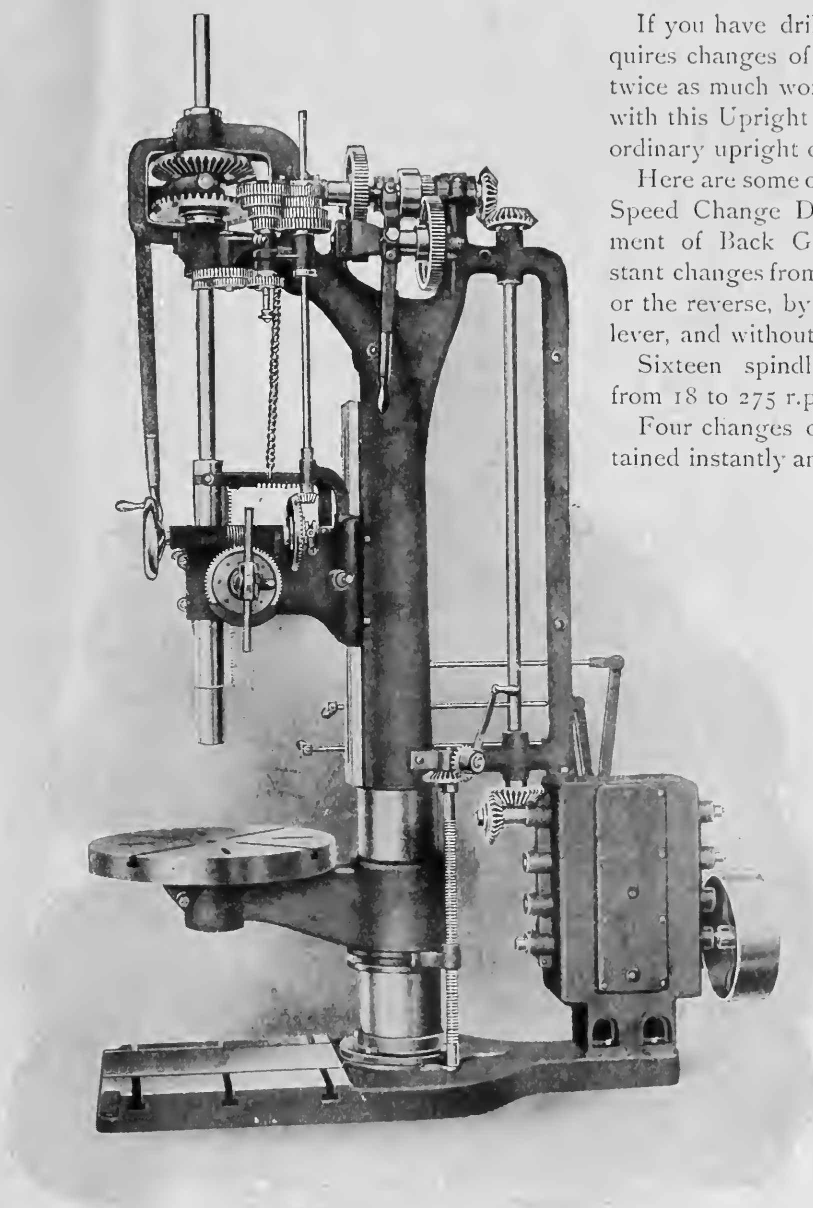
HURLBUT-ROGERS MACHINE CO.

So. Sudbury, Mass.

Your "Stock Account" will show a larger "credit," if you use McCullough-Dalzell Crucibles. They turn out more stock, in proportion to cost than other makes. Write for prices.

McCULLOUGH-DALZELL CRUCIBLE COMPANY, PITTSBURGH, PA.

The Drill of the Future



If you have drilling to do that requires changes of speed, you can do twice as much work in a given time with this Upright Drill as with any ordinary upright drill.

Here are some of the reasons: Gear Speed Change Device—an arrangement of Back Gears permitting instant changes from high to low speed, or the reverse, by simply operating a lever, and without stopping machine.

Sixteen spindle-speeds ranging from 18 to 275 r.p.m.

Four changes of geared feeds obtained instantly and without stopping the machine.

The geared feed eliminates slipping-feed-belt troubles.

Our improved quick return and stop motions make it possible to raise or lower the spindle and engage or disengage the power feed with one lever and with one hand.

Write by return mail for circulars and full details.

PRENTICE BROS. COMPANY

"Builders of Radial and Upright Drilling Machines, Engine and Turret Lathes"

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